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SIZE, WEIGHT AND CAPACITY OF FLY-WHEELS FOR PUNCHES.

FRANK B. KLEINHANS.*

In the February, 1907, issue of MACHINERY, a method was given to determine the strength of a punch frame to resist a given effort. In this article will be given the method of determining the size, weight and capacity of a fly-wheel to punch a given size hole through a given thickness of metal.

Effect of Relative Size of Punch and Die, and Shape of Punch.

To begin with, there are a number of things which affect the effort that is required to punch a certain size hole through a given thickness of metal. In Fig. 1, P is the punch, A is the diameter of the punch, and $A + x$ is the diameter of the hole in the die. For the regular run of work, and for a ¾-inch punch, the hole in the die would be about 1/32 inch larger

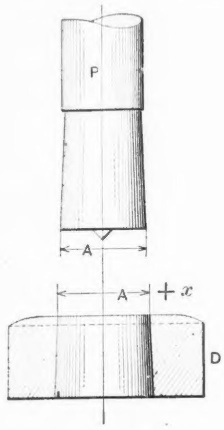

Fig. 1.

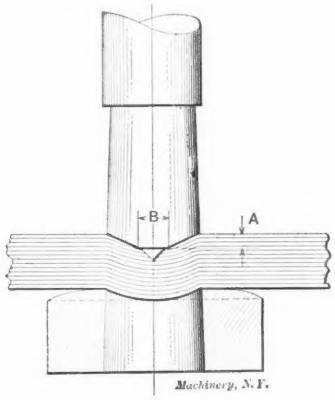

Fig. 2.

than the punch. If we reduce the size of the hole, the effort necessary to punch the hole will be greatly increased, and the life of the punch will be short, but if we increase the size of the hole, within certain limits, the effort required to punch the hole will be less, and the life of the punch will be greatly increased. The use of a large hole in the die causes a cone-shaped hole in the sheet, which is always more or less objectionable, and, therefore, one cannot get too far away from the standard proportions used by punch makers. The punching effort required will also be decreased by the use of a punch which has something of a shearing action, as shown at A, Fig. 2. The flat portion, B, enters the sheet first and probably presents no more than one-fourth the total cutting circumference of the punch. By the time the whole punch has entered into the sheet, which would represent the greatest effort required, the metal under B is nearly sheared away. Through the remainder of the stroke there is a shading off of the effort required to remove the metal. The shape of the punch with reference to the diameter on the end and on the body also has some effect upon the effort.

Fig. 3 shows a regular flat punch. The sides S are tapered off gradually from ¾ inch at the bottom to 11/16 inch at the top. Fig. 4 shows a similar punch with the sides parallel, but flaring off at the bottom for a distance of 3/16 inch. There is little difference in the effort required in using either of these punches when both are new. But when they become worn the side pressure against the punch amounts to considerable. It is this wearing off of the sides which causes the greatest trouble in punching. The style shown in Fig. 4 is used a great deal in structural work, and seems to give less trouble from side friction than the punch shown in Fig. 3.

Punching Effort Proportional to Area Sheared.

In calculating the size fly-wheel which will be necessary to punch a given hole, a flat punch only will be considered, and it will be assumed that the punches are kept in fairly good condition. Also, the calculations will be based upon punching wrought iron and steel, such as boiler plate, angles, tees, bars, etc.

The area sheared off in punching a 1-inch hole through a ¾-inch plate is the circumference of a 1-inch circle, times the thickness of the sheet. The circumference of a 1-inch circle is 3.1416 inches.

Let $A =$ area to be sheared

$= 3.1416 \times \frac{3}{4} = 2.3562$ square inches, or, say, for all practical purposes,

$= 2.36$ square inches.

For ordinary run of work, we will use a shearing resistance stress of 60,000 pounds per square inch. In working with harder or softer material, of course this shearing stress will have to be taken higher or lower, depending upon the shearing stress of different metals.

Let $P =$ the push required to punch the hole, or the shearing effort,

$S =$ shearing stress per unit of area

$= 60,000$ pounds per square inch.

We then have

$P = A \times S$, and for the case considered

$= 2.36 \times 60,000$

$= 141,600$ pounds $=$ effort required to punch a 1-inch hole through 3/4 plate.

In order to punch such a hole, a large amount of energy will be required for a brief period of time, as one can infer from the crank circle shown in Fig. 5, in which the punching is represented as being all done through the small portion T of the circumference. This distance represents the distance

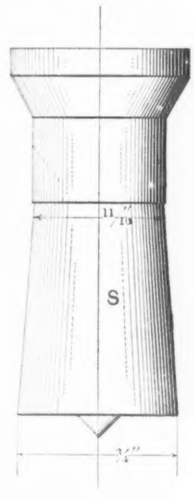

Fig. 3.

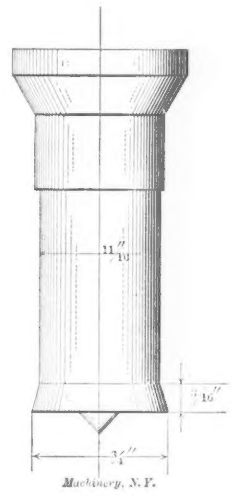

Fig. 4.

that the crank-pin passes through while removing the metal, D being the diameter of the crank-pin circle. It will be seen from the case shown that T represents about one-tenth of the crank circle. The energy required for punching would have to be given out in about one-tenth revolution of the eccentric shaft. During the meantime the machine can pick up energy through the other nine parts of the circumference. If the fly-wheel is properly proportioned, and if the energy applied to the machine is sufficient, the fly-wheel will pick up througn these nine parts of the circumference sufficient energy to do the punching while the crank-pin is passing through the tenth part of the circumference.

Design of Fly-wheel and its Function.

A good design of fly-wheel is shown in Fig. 6. The ledge L inside the fly-wheel extends from arm to arm, which makes

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very strong connections between the arm and rim. The outside diameter D of the fly-wheel as well as the sides are machined. The hub H should never be less than two diameters of the shaft. A good deal depends upon the strength of this hub, and as the extra metal required to increase the size of the hub is small in proportion to the size of the fly-wheel, it is good practise to make the hub, say, from 2½ to 3 diameters of the shaft.

In order that the fly-wheel shall give out energy, it must slow down in speed. If the fly-wheel is not large enough, the energy required will be greater than the capacity of the fly-

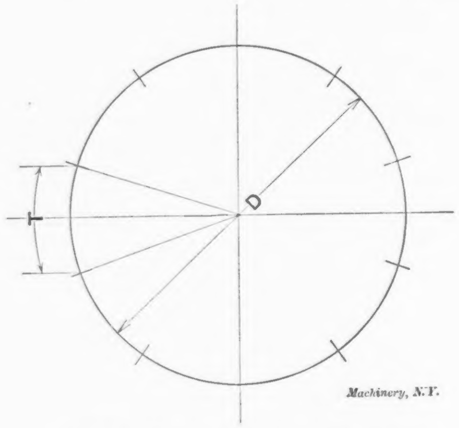


Fig. 5. Diagram of Crank-pin Circle.

wheel, and the change in speed will be great. In some cases a machine might even be stopped owing to the fly-wheel not having energy enough. If a fly-wheel is properly designed it will perform its work and slow down in speed a certain percentage, but this must not be so great that the machine cannot pick up again for the next stroke. The amount that the fly-wheel can be slowed down by taking its energy away from it is a matter of experiment. For ordinary punch and shear work we can take this drop in speed to be about 20 per cent while the machine is doing the work. This would have to be regained through the belt or through the motor during the remaining portion of the stroke so that the fly-wheel would be up to speed again for punching the next hole.

There are many belted punches which are running along and doing their work satisfactorily which are not at all up

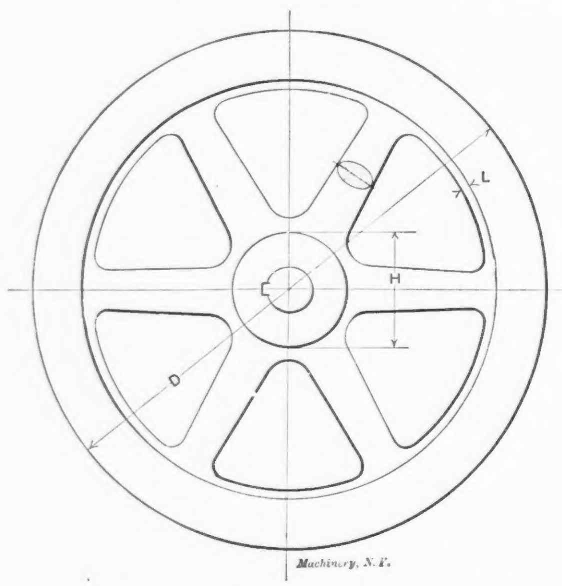


Fig. 6. Design of Fly-wheel.

to this standard of requirement. The reason for this is that these machines punch a hole only "once in a while." The drop in speed is very much greater than one-fifth, being probably one-third. If one should take such a machine with the rated capacity of 1 inch through ¾-inch plate, and punch one hole after the other without missing a stroke, the machine would stop. In this connection, therefore, it will be noted that there is a chance for a great variation in the size of fly-wheel and the horse-power required to drive a punch. In these calculations the fly-wheel will be so proportioned to punch its rated capacity for every stroke for continuous working.

To Calculate the Potential Energy of a Fly-wheel for a Given Reduction of Velocity.

Let V = velocity of center of gravity of fly-wheel rim at normal speed before punching, in feet per second,

E = the energy delivered to the fly-wheel or given out by the fly-wheel for one stroke,

W_r = weight of the rim,

W_a = weight of the arms,

$g = 32$ = acceleration due to gravity,

V_1 = velocity of center of gravity of fly-wheel rim after punching, in feet per second.

$$\text{Then } E = (W_r + \tfrac{1}{3} W_a)\left(\frac{V^2 - V_1^2}{2g}\right) \quad (1)$$

In this expression W_a represents the weight of the arm. This is a very small percentage of the total weight of the fly-wheel, and for all practical purposes we can neglect this item.

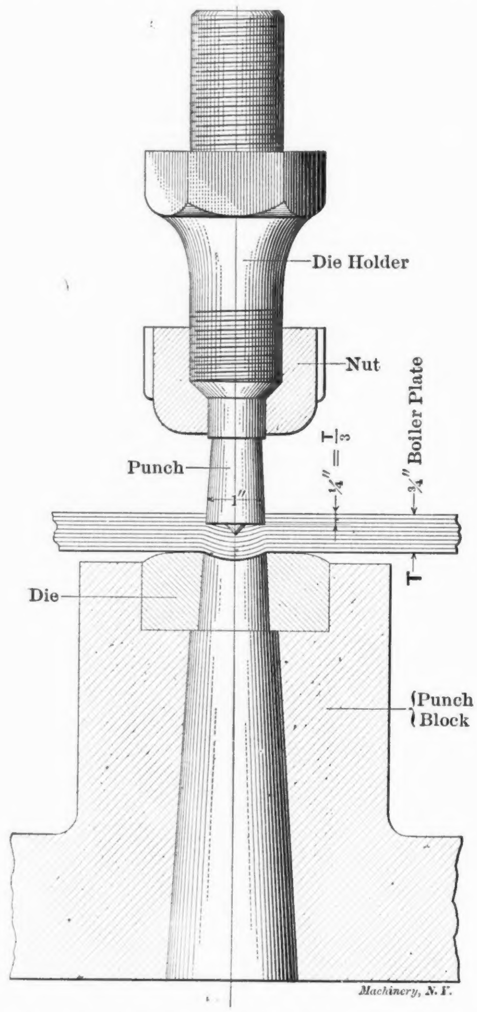


Fig. 7. Diagram Illustrating Part of Stroke Offering Maximum Resistance to Punching.

Neglecting item 1/3 W_a we have for (1)

$$E = W_r \frac{V^2 - V_1^2}{2g}$$

$$= W_r \frac{V^2 - V_1^2}{64} \quad (2)$$

To Calculate the Weight of the Fly-wheel.

E also equals the energy necessary to punch a 1-inch hole through a ¾-inch plate. Experiments show that when a punch has entered about one-third way through the sheet, see Fig. 7, the material is all sheared off, or in other words, when the punch has passed one-third way through the sheet, the hole is punched, and it then only remains to push the punching out through the die.

Let T = thickness of plate = ¾-inch; we then have

$$E = P \times \frac{1/3\,T}{12}$$

$$= \frac{P \times 1/3 \times \frac{3}{4}}{12}$$

$$= \frac{141{,}600}{4 \times 12}$$

= 2,950 foot-pounds = energy required per stroke.

By transposing equation (2), we have

$$W_r = \frac{E \times 64}{V^2 - V_1^{\,2}} \qquad (3)$$

In order to determine the size of the fly-wheel, we must know the speed of the fly-wheel, and we must assume a diam-

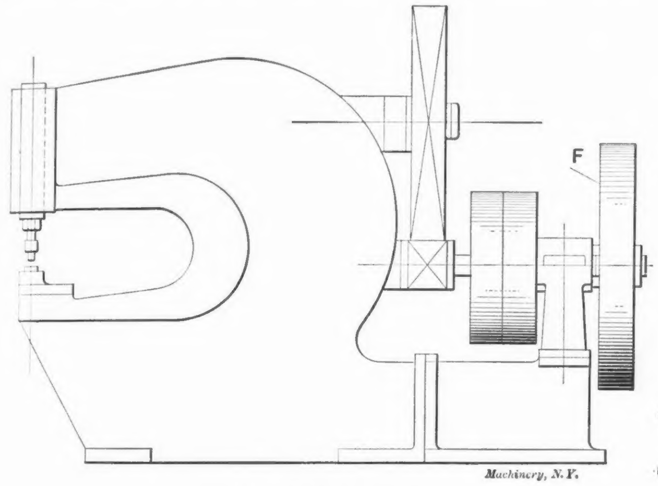


Fig. 8. Single-ended Punch.

eter which in our judgment would be approximately correct. We will take for the present case a single-ended punch, as shown in Fig. 8, with bottom drive, with tight and loose pulleys and with a single fly-wheel F running at a normal speed of 175 R. P. M. before punching and falling off 20 per cent during the actual punching operation. This machine should take a fly-wheel about 36 inches outside diameter, or say about 30 inches diameter of center of gravity of rim. The velocity in feet per second would be

$$V = \frac{\text{dia.} \times \pi}{12} \times \frac{175 \text{ R. P. M.}}{60 \text{ sec.}}$$

= 23 feet. Substituting in (3) we get

$$W_r = \frac{E \times 64}{V^2 - V_1^{\,2}} = \frac{2950 \times 64}{23^2 - 18.4^2}$$

= 992 pounds, weight of fly-wheel.

This fly-wheel would be made of cast iron and the section of the rim would be obtained thus:

Let B = the face of the fly-wheel (see Fig. 9) = 6¾ inches, H = the average thickness of the rim. We then have

$W_r = 6\frac{3}{4} \times H \times 30 \times \pi \times 0.26$, and transposing

$$H = \frac{W_r}{6\frac{3}{4} \times 30 \times \pi \times 0.26}$$

$$= \frac{992}{6\frac{3}{4} \times 30 \times \pi \times 0.26}$$

= 6 inches depth of rim.

The fly-wheel, therefore, should be 36 inches outside diameter with a rim 6¾ inches face by 6 inches thick.

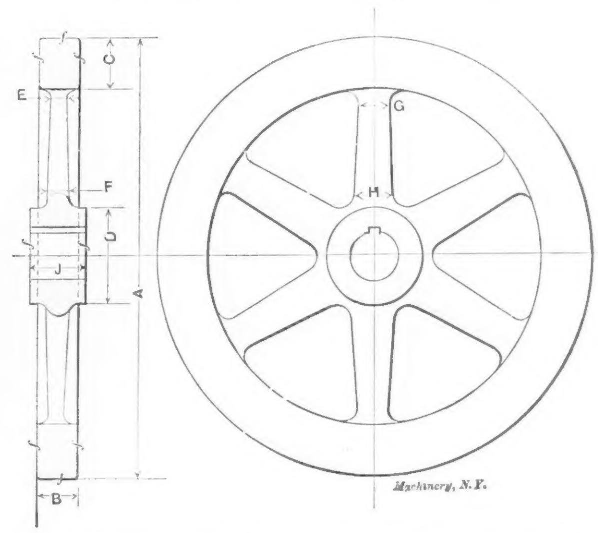
Effect of Frame Elasticity in Reducing Efficiency.

There is another thing which should be mentioned in connection with the size of a fly-wheel which would be required to do a certain amount of work. If the machine is not stiff in the frame or shafting a large amount of energy will disappear, and there is apparently nothing to show for it. This can best be explained by referring to Fig. 10, which shows a double-ended punch. If the shaft S is small in diameter, or if the distance between bearings B and B is great, this shaft will spring, and the result or the effect of the fly-wheel is "deadened." Also, if the eccentric shaft is very long and is small in diameter, it will have the same effect, hence the great importance of a solid machine for punching. It is remarkable what capacity the upright punching press has, but this is largely due to the very solid construction. The metal in the upright is in direct tension, therefore the spring or stretch is small. With a regular punching machine, however, there are a number of chances for spring, and each cuts down the flywheel effect.

With a short throat punch there is not much spring in the frame, but with a deep throat punch the spring amounts to considerable. A spring of ⅛ to 3/16 inch at the dies is a very common thing. A deep throat machine will punch way beyond its rated capacity if the tie-rods are used close up to the head. This stiffens the machine and concentrates the work of the fly-wheel onto the metal being punched. A short throat punch is usually rated higher in capacity than a deep throat punch of the same pattern. In figuring out the size fly-wheel, therefore, it should be made large enough to do the work of a short throat punch.

When a double-end punch is required, as in Fig. 10, one or two fly-wheels may be used. Frequently, on account of the limited space, two fly-wheels must be used. This wheel or wheels, as the case may be, should be calculated to do the

DIMENSIONS OF FLY-WHEELS FOR PUNCHES.



A	B	C	D	E	F	G	H	J	Max. R.P.M.
24	3	3½	6	1¼	1⅜	2¾	3¼	3½	955
30	3½	4	7	1⅜	1½	3	3¾	4	796
36	4	4½	8	1½	1¾	3¼	4¼	4½	637
42	4¼	4¾	9	1¾	2	3½	4½	5	557
48	4½	5	10	1¾	2	3¾	4¾	5½	478
54	4¾	5½	11	2	2¼	4	5	6	430
60	5	6	12	2¼	2½	4½	5½	6½	382
72	5½	7	13	2½	2¾	5	6½	7	318
84	6	8	14	3	3½	5½	7½	8	273
96	7	9	15	3½	4	6	9	9	239
108	8	10	16½	3¾	4½	6½	10½	10	212
120	9	11	18	4	5	7½	12	12	191

continuous work of both ends of the machine. It will be noted in equation (2) that E varies with the square of the velocity of the fly-wheel; we can take advantage of this fact sometimes, where a punch has a fly-wheel that is somewhat too light. The machine can be speeded up, which will give the fly-wheel more energy, and in this way will punch up to the capacity of the machine.

Limitations of Fly-wheel Size and Speed.

In practise there are a number of things which limit the diameter and speed of a fly-wheel, and in such cases the weight must be gotten by either increasing the face and thickness of the rim or else putting on two fly-wheels. The cut and the table given above state the dimensions of the flywheels. The last column gives the maximum R. P. M. at which a cast iron fly-wheel should be run. There are cases

where very high speeds of fly-wheels cannot be avoided, but as far as possible the tendency is to use a heavy fly-wheel at moderate speed and one or two runs of heavy gears.

If a punch is fitted with a proper size fly-wheel, and the motor or pulleys are too small when running on continuous work, the machine will slow down and stop. In the case of a belted machine, the belt will break or slide off the pulley, and in the case of motor drive, the motor probably will be so overloaded as to cause it to burn out after running awhile.

Calculation of Horse-power Required for a Punch, and Width of Belt.

We can determine the horse-power necessary to run a punch in the following manner: Take the case of a 1-inch diameter by ¾-inch punch, running 30 strokes per minute; we have

$E = 2{,}950$ foot-pounds energy per stroke,

Let $H.P. =$ horse-power,

$N =$ number of strokes per minute.

We then have

$$H.P. = \frac{E \times N}{33{,}000} \qquad (4)$$

$$= \frac{2{,}950 \times 30}{33{,}000}$$

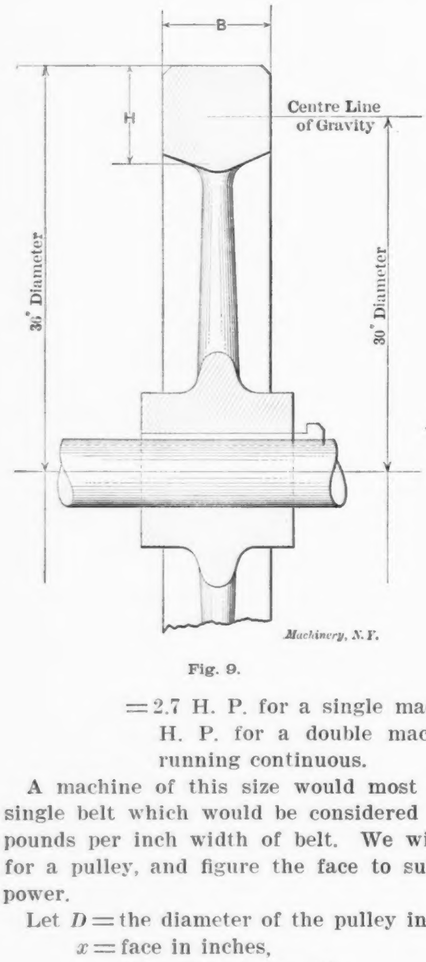


Fig. 9.

$= 2.7$ H. P. for a single machine, or $2 \times 2.7 = 5.4$ H. P. for a double machine with both sides running continuous.

A machine of this size would most likely be run with a single belt which would be considered to exert a pull of 40 pounds per inch width of belt. We will assume a diameter for a pulley, and figure the face to suit the required horse-power.

Let $D =$ the diameter of the pulley in inches—20 inches,

$x =$ face in inches,

$n = 175$ R. P. M. of pulley,

$$H.P. = \frac{D \times \pi}{12} \times \frac{40 \times x \times n}{33{,}000}, \text{ and transposing we get}$$

$$x = \frac{H.P. \times 12 \times 33{,}000}{D \times \pi \times 40 \times n} \text{ for single machine.} \qquad (5)$$

$$= \frac{2.7 \times 12 \times 33{,}000}{20 \times \pi \times 40 \times 175} = 2.45 \text{ inches belt width.}$$

$=$ say, 3 inches belt face of pulley for single punch.

For a double punch we would require twice the power, or, assuming 30 inches diameter for the pulley and substituting in (5), we get

$$x = \frac{5.4 \times 12 \times 33{,}000}{D \times \pi \times 40 \times n}$$

$$= \frac{5.4 \times 12 \times 33{,}000}{30 \times \pi \times 40 \times 175} = 3.27 \text{ inches belt width,}$$

$=$ say $3\frac{3}{4}$ inches belt face of pulley for double machine.

If these machines were to be motor driven, the single machine would require at least a 3-horse-power motor and the double machine from 5 to 7½ horse-power motor. A 5-horse-power motor would in all probability be all right, as a double machine would hardly be run so as to use every stroke. It is always best, however, to have a motor that is a little larger than is required, as punching is very severe work on the motor, especially when the motor is geared to the fly-wheel shaft through cut spur gears. The variation in speed jars the motor, and this tells on the windings, etc. The variation of the speed in the fly-wheel has less effect on the motor if it is belted, or if it is connected to the machine through a slip gear or a friction clutch.

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The chandeliers and fixtures for the light installation in the new Pennsylvania capitol, which have caused so much comment on account of the doubtful manner in which the state's money was expended, were manufactured by a company specially formed for this purpose. The company dis-

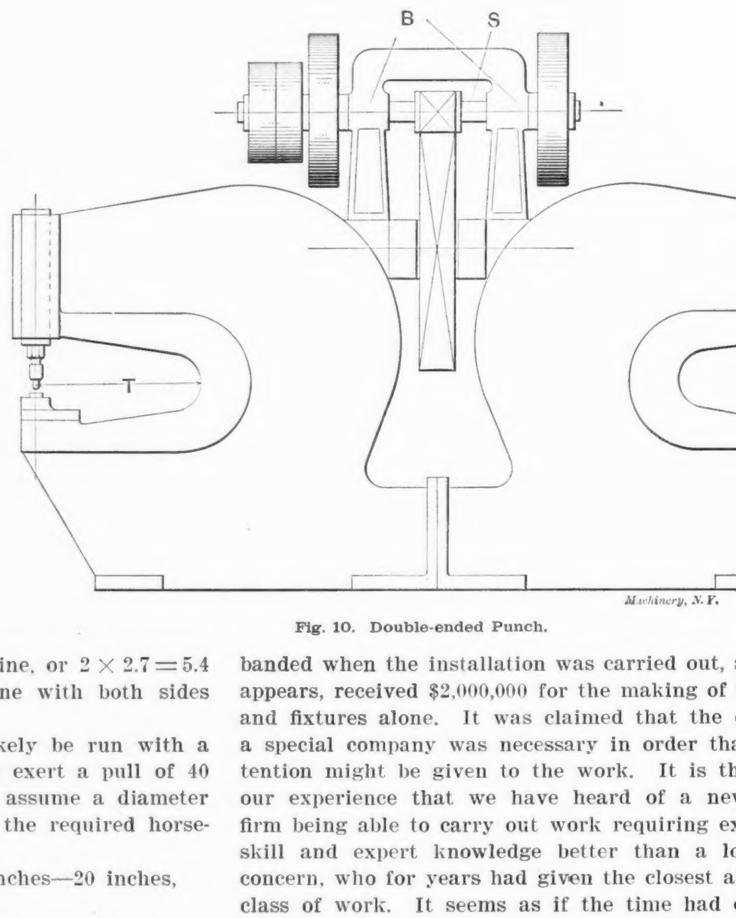

Fig. 10. Double-ended Punch.

banded when the installation was carried out, after having, it appears, received $2,000,000 for the making of the chandeliers and fixtures alone. It was claimed that the organization of a special company was necessary in order that exclusive attention might be given to the work. It is the first time in our experience that we have heard of a newly established firm being able to carry out work requiring exceedingly high skill and expert knowledge better than a long established concern, who for years had given the closest attention to this class of work. It seems as if the time had come when imperative need presents itself for the legitimate manufacturers and producers of the country to protest against such proceedings, which without doubt injure them in two ways: first, by depriving them of their legitimate right to fair competition, and secondly by requiring them to pay that tribute which must be paid in order to satisfy the doubtful interests which are connected with such parasitical business enterprises. Whenever somebody gets something for nothing, somebody else surely foots the bill. The capitol building in itself cost less than $4,000,000, but it appears that when fitted up according to the wishes of the persons responsible for the building, it cost between $13,000,000 and $14,000,000. As this is not one single case, but happens quite often when public buildings are erected, and as it concerns the manufacturers and producers of the country far more than they themselves seem to realize, it is appropriate to call attention to the matter.

DESIGN OF THICK CYLINDERS.*

WITH SPECIAL REFERENCE TO HYDRAULIC PRESS CYLINDERS.

T. A. MARSH.†

T. A. Marsh.‡

A phase of design on which there are but few available data is that of thick cylinders for pressures above one thousand pounds per square inch. Comparatively few hydraulic press cylinders work at a less pressure than this, and designing must be done very carefully both regarding strength and distribution of the metal.

Lamé's formula for thick cylinders in its usual form is rather inconvenient for handling, so the writer uses the following forms of the same formula, obtained by substitution:

$$S = P\frac{R^2 + r^2}{R^2 - r^2} \qquad (1)$$

$$R = r\sqrt{\frac{S + P}{S - P}} \qquad (2)$$

$$r = R\sqrt{\frac{S - P}{S + P}} \qquad (3)$$

$$P = S\frac{R^2 - r^2}{R^2 + r^2} \qquad (4)$$

$$T = r\left(\sqrt{\frac{S + P}{S - P}} - 1\right) \qquad (5)$$

in which:

S = Maximum allowable fiber stress per square inch,
R = Outer radius of cylinder, in inches,
r = Inner radius of cylinder, in inches,
P = Working pressure of liquid within cylinder,
$T = R - r$ = thickness of cylinder, in inches.

Form (2) of this equation may be transposed to read

$$\frac{R}{r} = \sqrt{\frac{S + P}{S - P}}$$

which reads "the ratio of the outer radius to the inner radius is equal to the square root of the quotient of the difference of the allowable working stress and the working pressure into the sum of the same." By allowing these last-named quantities to vary over a considerable range, the writer has prepared a table of ratios of outer to inner radii, from which one may, without calculation, determine the thickness of a cylinder wall. Careful study of this form of the equation reveals that as the pressure P approaches the allowable stress S, the ratio $\frac{R}{r}$ increases very rapidly; it becomes infinite when the pressure equalizes the allowable stress, and becomes an imaginary quantity when the pressure is greater than the allowable stress. In practise, this means that for each metal there is a limiting pressure, beyond which it is impossible to design a safe cylinder, and a metal of higher tensile strength must be employed. Further, for every factor there is a pressure point for each diameter of cylinder beyond which it is economy to resort to a better grade of material. The allowable stress is a

RATIOS OUTSIDE RADII TO INSIDE RADII, THICK CYLINDERS.

Allowable Stress of Metal per square inch Section.	Working Pressure in Cylinder, Pounds per Square inch.												
	1000	1500	2000	2500	3000	3500	4000	4500	5000	5500	6000	6500	7000
2000	1.732	....	....	....	....	....	....	....	....	....	....	....	....
2500	1.527	2 000	....	....	....	....	....	....	....	....	....	....	....
3000	1.414	1.732	2.236	....	....	....	....	....	....	....	....	....	....
3500	1.341	1.581	1.915	2.449	....	....	....	....	....	....	....	....	....
4000	1.291	1.483	1.732	2.081	2.645	....	....	....	....	....	....	....	....
4500	1.253	1.414	1.612	1.871	2.236	2.828	....	....	....	....	....	....	....
5000	1.224	1.362	1.527	1.732	2.000	2.380	3.000	....	....	....	....	....	....
5500	1.201	1.322	1.464	1.633	1.844	2.121	2.516	3.162	....	....	....	....	....
6000	1.183	1.291	1.414	1.558	1.732	1.949	2.236	2.645	3.316	....	....	....	....
6500	....	1.264	1.374	1.500	1.647	1.825	2.049	2.345	2.768	3.464	....	....	....
7000	....	1.243	1.341	1.453	1.581	1.732	1.914	2.144	2.449	2.886	3.605	....	....
7500	....	1.224	1.314	1.414	1.527	1.658	1.813	2.000	2.236	2 549	3.000	3.741	....
8000	....	1.209	1.291	1.381	1.483	1.599	1.732	1.889	2.081	2.323	2.645	3.109	3.872
8500	....	1.194	1.271	1.354	1.446	1.548	1.666	1.802	1.963	2.160	2.408	2.738	3.214
9000	....	1.183	1.253	1.330	1 414	1.507	1.612	1.732	1.871	2.035	2 236	2.440	2.828
9500	....	....	1.235	1.306	1.386	1 472	1.566	1.673	1.795	1.936	2.104	2.309	2.569
10000	....	....	1.224	1.291	1.362	1.441	1.527	1.623	1.732	1.856	2.000	2.171	2.380
10500	....	....	1.212	1.274	1.341	1.414	1.493	1.581	1.678	1.789	1.915	2.061	2.236
11000	....	....	1.201	1.260	1.322	1.390	1.464	1.544	1.633	1.732	1 844	1.972	2.121
11500	....	....	1.193	1 247	1.306	1.369	1.437	1.511	1.593	1.683	1.784	1.897	2.027
12000	....	....	1.183	1.235	1.291	1.359	1.414	1.483	1.558	1.640	1.732	1.834	1.949
12500	....	....	....	1.224	1.277	1.333	1.393	1.457	1.527	1.603	1.687	1.779	1.878
13000	....	....	....	1.215	1.264	1.318	1.374	1.434	1.500	1 570	1.647	1 732	1.825
13500	....	....	....	1.206	1.253	1.303	1 357	1.414	1.475	1 541	1.612	1.690	1.775
14000	....	....	....	1.197	1.243	1.291	1.341	1.395	1.453	1.514	1.581	1.653	1.732
14500	....	....	....	1.189	1.233	1.279	1.327	1.378	1.432	1.490	1.553	1.620	1.693
15000	....	....	....	1.183	1.224	1.268	1.314	1.362	1.414	1.469	1.527	1.590	1.658
15500	....	....	....	1.177	1.216	1.258	1.304	1.348	1.397	1.449	1.504	1.563	1.627
16000	....	....	....	1.170	1.209	1.249	1.291	1.335	1.381	1.431	1.483	1.538	1.599

* The following articles on the strength of hydraulic cylinders have previously appeared in MACHINERY: Strength of Hydraulic Cylinders, May, 1896; Strength of Hydraulic Cylinders, July, 1896; Thick Cylinders, August, 1896; Thick Cylinders, September, 1905.

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‡ Thomas A. Marsh was born in London, England. He graduated from Illinois University in 1904. During vacations, prior to graduation, he was with the Western Electric Co., Chicago, Ill., and Allis-Chalmers Co., Milwaukee, Wis.; and since graduation he has been with the Aultman & Taylor Machinery Company, Mansfield, Ohio; Hydraulic Press Mfg. Co., Mt. Gilead, Ohio, and Green Engineering Co., Chicago, Ill., with which concerns he has held positions of tracer, draftsman, designer, mechanical engineer and inspector. Mr. Marsh is a junior member of the American Society of Mechanical Engineers and an honorary member of the National Association of Steam Engineers.

figure dependent on the elastic limit of the material. In hydraulic cylinders we are usually safe in working the material up to fifty per cent of the elastic limit.

In designing a cylinder to give a certain tonnage it is well to bear in mind the following points:

1. With a fixed pressure, the tonnage increases as the square of the diameter.

2. When the pressure exceeds 2,500 pounds per square inch, packings become leaky, valves do not hold, and pipe fittings give trouble; for these reasons it is advisable to keep the pressure below this point, but as this necessitates a larger cylinder, cost often prohibits.

Suppose a cylinder is required to give 95 to 100 tons pressure:

An 11-inch cylinder working at 2,000 pounds gives 95 tons, a 10-inch cylinder working at 2,500 pounds gives 98 tons, and a 9-inch cylinder working at 3,000 pounds gives 95 tons.

For calculation let us take the 10-inch cylinder working at 2,500 pounds, and let our material be cast iron, whose allowable stress is 6,000 pounds per square inch. By substituting in formula (5)

$$T = 5\left(\sqrt{\frac{6000 + 2500}{6000 - 2500}} - 1\right)$$

T = thickness of cylinder wall, 2.79 inches.

Reference to the table of ratios under column of 2,500 pounds pressure and on the line of six thousand pounds allowable stress, gives the ratio 1.558.

It is well to leave more metal in the bottom of a hydraulic cylinder than the design would seem to require, for the reason

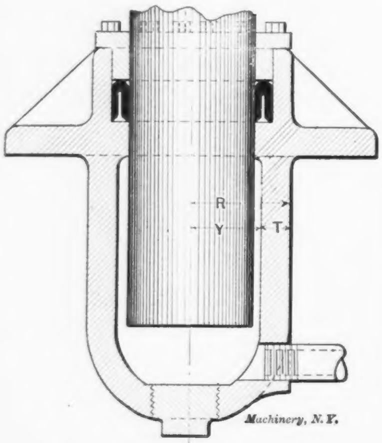


Fig. 1.

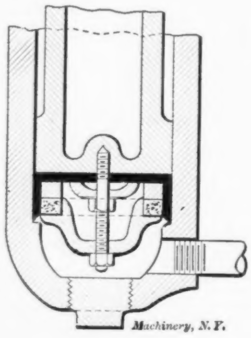


Fig. 2

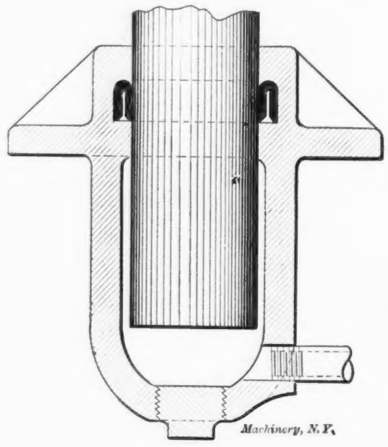


Fig 3.

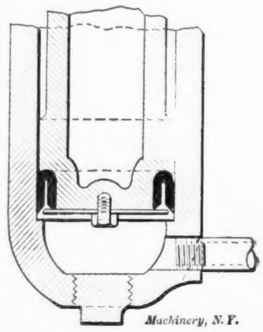


Fig. 4.

that a hole of some size must be cored in the bottom to permit the entrance of a boring bar when finishing the cylinder, and when this hole is subsequently tapped and plugged it will be found a fertile source of trouble.

Flanged cylinders, Figs. 1, 2, 3, and 4, are the type usually employed in hydraulic press work, and in addition to withstanding bursting pressure, they must withstand the beam load on the flanges. The frequent point of failure is at the junction between the flange and the cylinder. This section is usually further endangered as the internal stresses set up by the cooling of the casting are severe, and the metal usually "draws" away because of the more rapid cooling of the flange. For this reason, care should be taken to avoid having thin portions leading abruptly from thick portions.

Patterns should be parted just above the flange, and all cylinders should be cast with open end up so that the dirt in the iron will accumulate at the top of the casting where it can do little harm. On short cylinders, the sprues should come off from the flange and upper edge of the cylinder. On long cylinders it is necessary to have sprues further down, and it is not infrequent that the spongy spots where the sprues have been removed have to be plugged.

Porous castings may be treated in several ways: A strong sal-ammoniac solution is a very common treatment, as is also common salt. Starch or wood pulp left under pressure will sometimes prove effective.

The common forms of hydraulic packings are: U packing with a removable follower, Fig. 1; cup packing on the end of the ram, Fig. 2; U packing in a chamber in the neck of the cylinder, Fig. 3; and U packing on the end of the ram, Fig. 4. The U packing with the removable follower seems to be the most mechanical and gives very excellent results under any pressures. There is much contention among the competing press builders regarding the best style of packing, but the writer's observation has been, that with good workmanship and a good packing, there is little choice as to efficiency, the main point being accessibility for repacking.

* * *

INVESTIGATION OF SMOKE-CONSUMING DEVICES.

The common council of Syracuse having passed an ordinance for the prevention of smoke, the chamber of commerce of that city has started an investigation of smoke-consuming devices with the idea of recommending to its manufacturers and merchants who come under the provisions of the ordinance, the best and cheapest means of preventing the issuance of smoke from their chimneys. The technical talent of this committee is rather remarkable, the committee being made up as follows: John A. Mathews, chairman, of the Crucible Steel Company of America; William Kent, Syracuse University; John H. Barr, of the Smith Premier Typewriter Company; John E. Sweet, president of the Straight Line Engine Company; J. D. Pennock, of the Solvay Process Company; W. H. Blauvelt, managing engineer of the Semet Solvay Company, and C. A. Chase, president of the Syracuse Chilled Plow Company. This committee intends to make a thorough study of smoke consuming devices, and its report should be of the greatest value to merchants and manufacturers not only in Syracuse, but throughout the rest of the country.

* * *

There is at the present time a considerable movement on this continent toward the recognition of the necessity and utility of a system of internal waterways, which would be of such a character as to accommodate modern shipping requirements. In the United States there has been some agitation for a waterway from the Great Lakes to the Gulf, effected by deepening and widening the Chicago drainage canal as well as deepening the channel in the Mississippi River. The Canadian Government is making estimates for what is called the Georgian Bay Ship Canal from Lake Huron to Montreal. With the enormous progress of our railroad building we have overlooked the utility of internal waterways to a greater extent than has been done in Europe, where railway and canal building in many cases has been carried on, so to say, simultaneously. In many cases low freight rates are far more important than high speed, and internal waterways are a necessary adjunct for the full industrial development of any country consisting of such a great continent as does the United States. It does not even seem to be a very radical statement to say that a deep waterway from the Lakes to the Gulf would confer upon this country a greater impetus to industrial development, and be a greater cause of general prosperity, than will the Panama Canal, and at an expense of probably only one-half or one-third of that of the latter waterway.

AUTOGENOUS WELDING.*

THE OXY-ACETYLENE PROCESS OF UNITING METALS.

The Worcester Pressed Steel Company, Worcester, Mass., has just installed a plant for autogenous welding with the oxy-acetylene blowpipe flame. This is the only welding plant of its kind in Worcester and the second in this country. The company quickly appreciated the practical value of adding this welding process to its equipment for the manufacture of high-class pressed steel parts for automobiles, bicycles and many special designs in deep drawing and cold forging, requiring skilled mechanics and the best machinery.

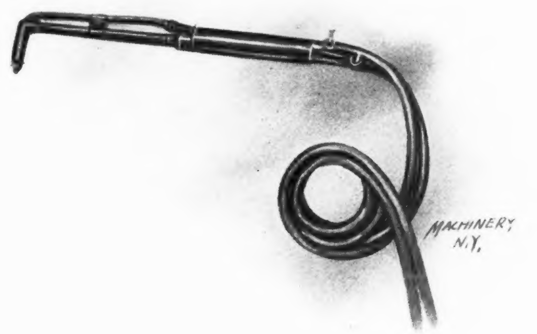


Fig. 1. Oxy-acetylene Blow-pipe.

In this welding process, oxygen and acetylene are employed in a blowpipe flame for obtaining the required heat. Each gas is generated in a separate apparatus and conveyed through separate pipes to the blowpipe. The distinctive feature which has done the most to make this welding process of wide commercial value is the introduction of a means for producing oxygen. By combining a chemical product, known as "epurite," with water, chemically pure oxygen is as easily obtained as, in uniting calcium carbide and water, acetylene is liberated, the chemical reaction in each case being analogous. Epurite is composed of chloride of lime, sulphate of copper and sulphate of iron. The sulphate of copper is pulverized and mixed dry with the chloride of lime. In making oxygen, 50

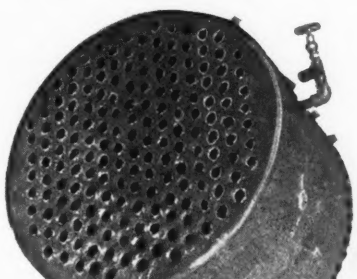


Fig. 2. Steel Boiler Tubes Welded in.

pounds of this dry mixture are dissolved in warm water. To this solution is added a solution of about 7 pounds of sulphate of iron dissolved in one gallon of water.

The oxygen generating apparatus consists of two lead-lined generating chambers arranged with a scrubber and settling chamber between. In making oxygen, one generator is filled with the required amount of lukewarm water to which one chemical charge is added. While this solution is being stirred with an agitator operated by a crank provided for the purpose, a solution of iron sulphate and water is added which acts as a catalyzer. In the following chemical reaction,

$$6\,Fe_2SO_4Aq + 7\,CaOCl_2Aq + CuSO_4Aq = 2\,Fe_23\,SO_4Aq + CuSO_4Aq + Fe_2Cl_6 + 7\,CaCl_2 + 3\,CaSO_4 + 7\,O,$$

the oxygen, liberated, passes from the generator through the scrubber and a water-sealed trap into the gasometer; from the gasometer, the oxygen is compressed to 10 atmospheres (147) pounds, with an air compressor, into a pressure storage tank. It is then conducted through 3/8-inch copper piping, from which branches of 1/4-inch copper piping lead to the blowpipe connections. Reducing valves are arranged so the operator can vary the pressure of the gas at the blowpipe at will. Each blowpipe is supplied with twenty-two different sized nozzles so the size and power of the flame can be varied according to the thickness of the metal to be welded.

The acetylene generator is of the water-feed type, composed of a cylindrical shaped tank, which serves as a gasometer and regulator, connected by three water supply pipes to three carbide receptacles or trays, half cylindrical in shape, each containing six compartments. Each tray holds about 12 pounds of lump carbide. The acetylene is used under practically a uniform pressure varying from 2.2 to 3 pounds. The pressure is obtained and maintained by two water levels in the gasometer, employing as a means the principle of the well-known

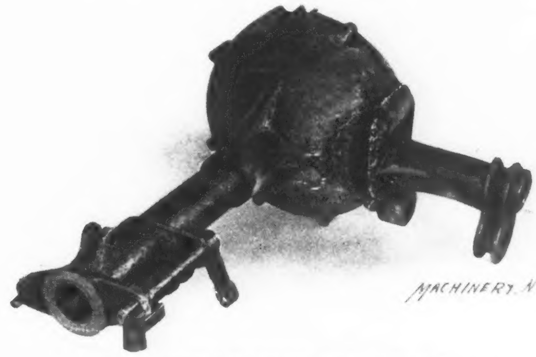


Fig. 3. Welded Cast Iron Automobile Gear Case.

water column, which automatically governs the supply and pressure of the gas. Any pressure in excess of 3 pounds escapes through a vent or blow-off outside the generator building. From the regulator and gasometer, the acetylene is conveyed through a 1-inch main pipe with one 3/8-inch branch leading to each blowpipe connection.

A feature of this acetylene apparatus is a "safety valve" located between the blowpipe connections and the acetylene gasometer. This consists of a 1-inch pipe leading into, and two 1-inch pipes leading out from a rectangular metal chamber.

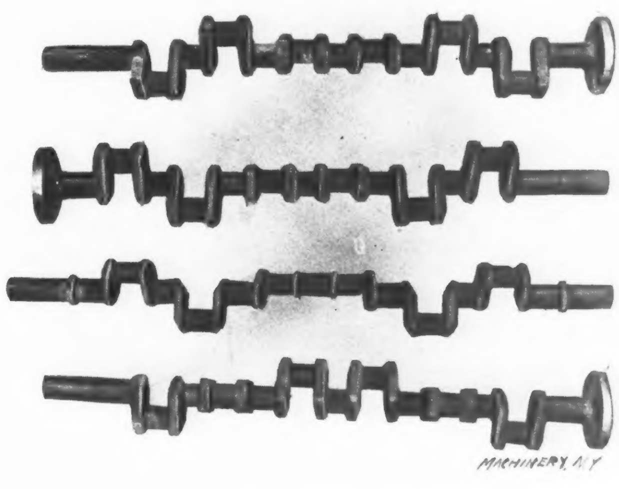


Fig. 4. Welded Crank-shaft Forgings.

The inlet pipe connects with the gasometer. One outlet conveys the acetylene to the blowpipes, the other vents to the outside air. The inlet and outlets are separated by a water-sealed trap which prevents any possibility of ignition reaching the generator and gasometer by burning back through the blowpipe supply pipes.

The blowpipe is of brass construction specially designed on

* See MACHINERY, Engineering Edition, May, 1906, page 469, and September, 1906, page 27.

the injector principle and carefully proportioned for its intended purpose. It is about 24 inches long and weighs 2 pounds. It is provided with two inlets which remain entirely separate practically the entire length of the blowpipe and enter a mixing chamber with a common outlet at the point of combustion. Acetylene (C_2H_2) is a hydro-carbon colorless gas of an ethereal odor, when perfectly pure, but as ordinarily obtained, is distinctly offensive to the smell. It is also an endothermic (heat-absorbing) gas nearly as heavy as air, having a density of 0.92 of air. It is obtained by bringing calcium carbide (CaC_2) in contact with water. The final chemical reaction is indicated by $CaC_2 + 2\,H_2O = C_2H_2 + Ca(OH)_2$. As acetylene is so rich in carbon—containing 92.3 per cent—it is possible, when mixed with air in a Bunsen burner, to obtain 3100 deg. F., and when combined with oxygen, 6300 deg. F. is produced, which is the hottest flame known as a product of combustion, and nearly equals the electric arc. This is about 1200 degrees higher than the oxy-hydrogen blowpipe flame.

In lighting the blowpipe, the acetylene is first turned on full; then the oxygen is added until the flame is only a single cone. At the apex of this cone is a temperature of 6300 deg. F. In welding, this point is held from 1/8 to 1/4 inch distant from the metal to be welded. Too much acetylene produces two cones and a white color; an excess of oxygen is indicated by the flame assuming a violet tint.

Theoretically, 2 1/2 volumes of oxygen are required for complete combustion of 1 volume of acetylene. Practically, however, with the oxy-acetylene blowpipe the best welding results are obtained with 1.7 volumes of oxygen to 1 volume of acetylene. The acetylene is, therefore, not completely burned with the blowpipe, according to the reaction (1):

$$2\,C_2H_2\ (4\text{ vol.}) + 5\,O_2\ (10\text{ vol.}) = 4\,CO_2 + 2\,H_2O,$$

but it is incompletely burned according to the reaction (2):

$$C_2H_2\ (2\text{ vol.}) + O_2\ (2\text{ vol.}) = 2CO + H_2.$$

This is understood when we consider that at the intense heat produced by this combustion, the water and carbon-dioxide formed by reaction (1) are completely dissociated. To this last fact is chiefly due the success of the oxy-acetylene flame as a welding agent. To establish the proper conditions for autogenously welding two metals it is necessary to bring them to their melting point without oxidizing or carbureting. As shown by the formula, this flame consists largely of carbon-monoxide, which is being converted at its extremity into carbon dioxide. This, with the hydrogen, forms a relatively cool jacket which protects the molten metal and the inner cone from loss of heat.

Fig. 5. Welding 3-8 inch Steel Tanks.

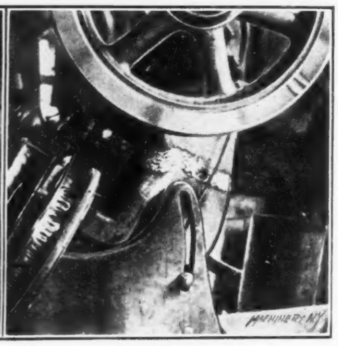


Fig. 6. Welded Cast Iron Power Press Frame.

At the moment of initial combustion, when the acetylene is decomposed into elements of carbon and hydrogen, about 300 B. T. U. per cubic foot of the gas are generated. The total heat, however, generated per cubic foot of acetylene is about 1500 B. T. U., which, aside from the initial decomposition, is furnished mainly by the combustion in oxygen of the carbon into carbon dioxide and in lesser degree by the combustion of hydrogen into water vapor. Pure acetylene at a pressure of less than 30 pounds, even when passed through pipes at white heat, is perfectly safe, but when mixed with oxygen (or air) is dangerous. An explosive gas mixture enclosed in a pipe, does not inflame at once throughout the entire pipe but from one end of the pipe, ignition travels at a certain speed, which increases as the square of the pipe section; therefore, to render safe the use of oxygen and acetylene in the blowpipe flame, the gas mixture is given a speed greater than the rate of propagation of the flame.

No flux or molds are required to weld metals such as iron, steel, and copper, but for alloys, *viz.*, brass, bronze, etc., a little borax or boracic acid, moistened with water, is used simply to prevent the volatilized zinc from being deposited on the joint and destroying the weld. This process welds by fusion, forming a perfect metallic union of the parts, which is imperceptible after finishing. It is not brazing. The Worcester Pressed Steel Co. employs it in place of riveting and soldering, and for other forms of metal construction not heretofore possible. Two sheets of metal may be welded by placing their edges in contact and following along the seam with a blowpipe. Tanks of almost any shape may be made by forming the body and ends separately and, in assembling, tracing the seams (joints butt and flush) with a blowpipe. To insure strength, the joint is slightly "overloaded" by melting a wire or rod of same material as metal to be welded, at the same time the edges are fused. The unfinished joint is stronger than the body of the metal, and the finished joint is practically the same.

Fig. 7. Welding Cast Iron.

Fig. 8. Heavy Welded Steel Tank.

Any shape hole can be easily cut in steel plates up to 6 inches thickness, as with the blowpipe the operator can accomplish cutting feats impossible with a saw. In cutting, the flame is proportionately elongated by pressure to penetrate to the bottom of the cut. The intense heat is so localized that the kerf is practically the same as if a saw were used.

Not only is this process adapted for making tanks, boilers, tubing, cylinders, pipe joints and angles, and for replacing brazing and riveting in many instances, but it effectively welds cast iron. In the foundry, this apparatus saves defective castings in iron, steel, brass, copper, etc., for the blowholes can be readily filled and broken castings welded as strongly as new. In repair work it is especially valuable, and many expensive castings, forgings and machined parts may be saved from the junk pile by an hour's use of this blowpipe.

An operator of average ability can weld steel or copper sheets at the rate and cost for gas approximately as follows:

		Cost per inch.
0.035 inch (about 1/32 inch),	288 inches per hour,	\$0.0031
0.062 inch (about 1/16 inch),	200 inches per hour,	0.0065
0.125 inch (about 1/8 inch),	120 inches per hour,	0.016
0.377 inch (about 3/8 inch),	60 inches per hour,	0.075

Metals 1/4 inch and less in thickness can ordinarily be welded cheaper than riveted. Steel and copper tanks for high and low pressure of almost any dimensions, are effectively welded in place of riveting; broken steel shafts and other forgings are repaired, cast iron welded with copper or steel and blowholes and similar defects in castings and forgings made good.

The company has accomplished some difficult autogenous welding with aluminum, practically overcoming the trouble from the oxide which forms on the surface of aluminum when exposed to the atmosphere. Although aluminum melts at a comparatively low temperature (1200 deg. F.), it rapidly conducts and absorbs heat, and requires a comparatively high local heat to obtain the best results.

WORKS OF THE LANDIS TOOL CO.

H. F. NOYES.*

One of the younger machine tool manufacturing establishments which has grown rapidly within the past few years, is that of the Landis Tool Co., Waynesboro, Pa., the largest exclusive manufacturers of wet-grinding machinery in this country. This firm manufactures at present only cylindrical grinding machines, ranging in sizes from 10 x 20-inch to 30 x 198-inch, and including about fifty different types; it employs over 450 men, the number of employes having more than doubled within the past three years. The illustration, Fig. 1, shows a general view of the plant, taken from behind the works. Fig. 2 is a ground plan of the property, and the remaining photographs are views taken in the different departments.

Several buildings and a good deal of machinery have been added within the last two years. The older machine shop, which was originally separated from the office building by about 60 feet, has been connected with it, and an addition also put on the other end, making an increase in floor space of about 10,000 square feet. About 2,000 square feet has been added to the foundry, and a separate building erected for the cleaning of castings and storage of the smaller castings, the larger ones being stored out-of-doors, in the yards. The power plant has been rebuilt entirely, as formerly most of the power consumed was obtained from the city.

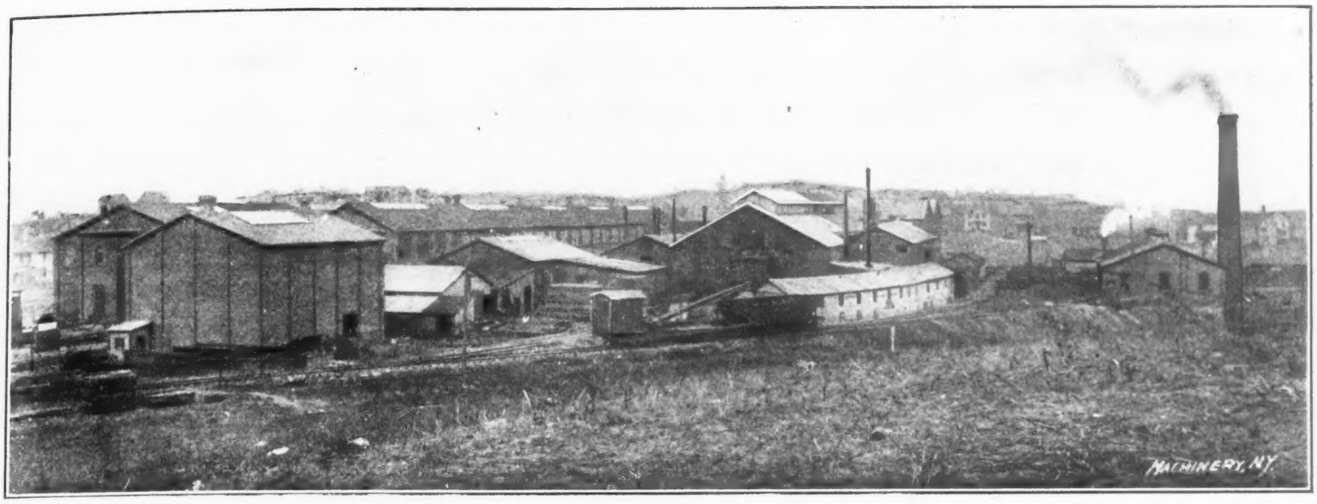


Fig. 1. General View of Landis Tool Co.'s Shops, Waynesboro, Pa.

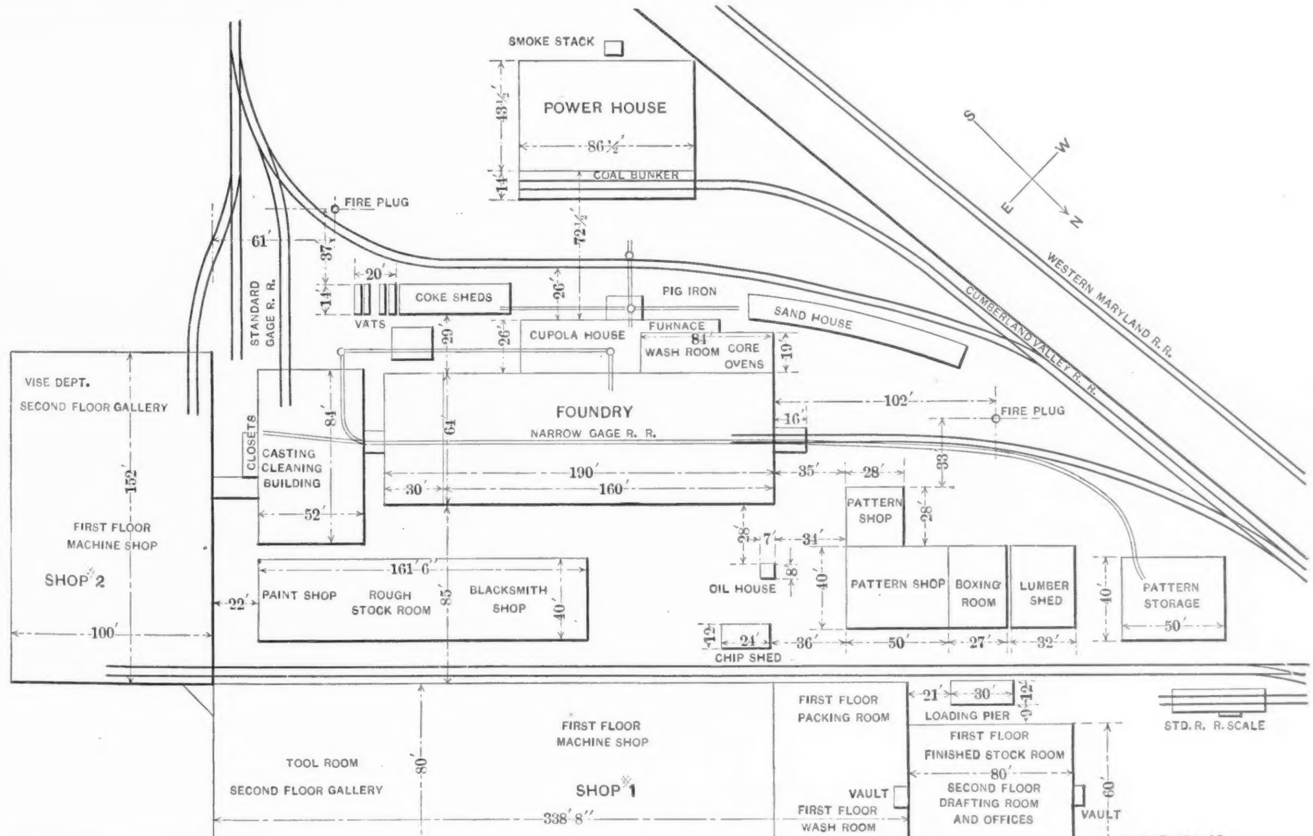


Fig. 2. Plan of Landis Tool Co.'s Property, Waynesboro, Pa.

Shipping facilities are afforded by direct connection with both the Western Maryland R. R. and the Cumberland Valley R. R. Standard gage tracks are laid to both machine shops, to the power plant and to the foundry, and in addition are so arranged as to cover a good portion of the yards used for storage purposes. A locomotive crane is used for transferring heavy work from one point to another. In addition, a narrow gage road connects the foundry, casting cleaning building, pattern-storage house and yards, for handling lighter materials.

The boiler plant comprises three 150 H.P. boilers, generating steam at 125 pounds pressure. A feature of the arrangement of these boilers is the high firebox, about 5 feet being allowed over the grate surface, it being Mr. Landis' belief that better combustion and greater efficiency is to be obtained by this construction, and the results seem to bear out this theory.

* Address: Waynesboro, Pa.

Power is obtained from two 300-H.P. direct-connected engines, coupled with two 200-K.W. generators, 220 volts, direct-current. The plant is operated in divisions of 25 to 50 H.P., each comprising a line-shaft driven by a suitable size motor, according to the requirements of the various departments. The larger machines are operated by individual motors.

The buildings are heated throughout by the Sturtevant system of forced hot air circulation, exhaust steam being chiefly used for heating the air.

The foundry is of about 12,000 square feet floor space, the building being of brick and steel construction. The core-room and ovens are arranged at the northwest end of the building. The photograph, Fig. 3, was taken from this end of the building, and gives an interior view taken just as the foundrymen were beginning to pour, and shows at the right a stream of metal issuing from the cupola. An electric crane of 15 tons capacity and 30-foot span covers the entire west side of the building, and the lighter work and molding machines are arranged on the other side. The castings are cleaned both by hand and by sand-blast in a separate building.

Fig. 3. Foundry, Landis Tool Co.'s Shops.

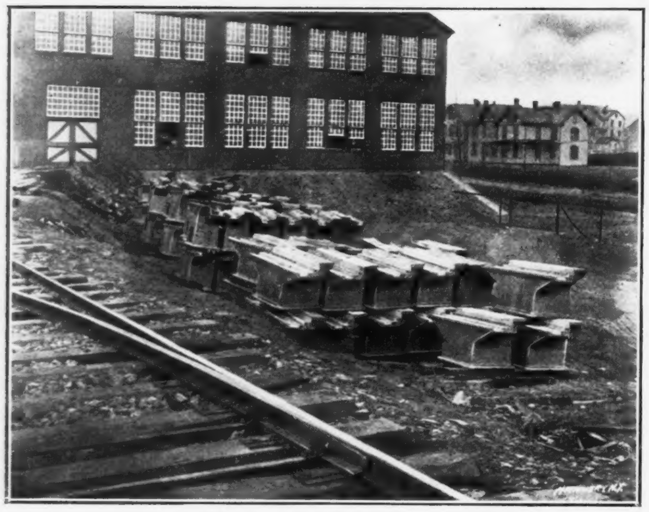


Fig. 4. Outside View of Foundry.

The property provides ample yard space for the storage of heavy castings, it being the practise to weather all parts where accuracy of form is required, such as beds, as long as possible. Fig. 4 shows a lot of about 100 beds left out to season.

The machining is done in two shops, forming the two parts to an L, one being 338 by 80 feet, and the other 150 by 100 feet. Each is arranged with a gallery at one side, the other side being left clear for operating an electric crane, each crane being of 20 tons capacity. The first floor of shop No. 1 is devoted on the side under the gallery to lighter lathe work, milling, drilling, and grinding. The space under the crane is used for scraping and assembling machines, the scraping being done nearer the southern part of the building, and the parts and machines gradually moving along toward the other end, as they go through the successive steps of assembling and packing.

The gallery above is divided off at one end for the tool-room, and the other end is devoted to automatic screw machines, gear cutters and thread millers. Next to the offices is a room devoted to experimental work.

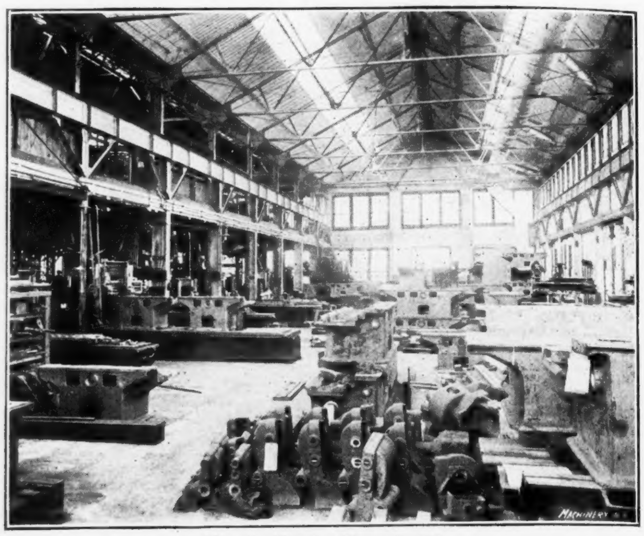


Fig. 5. Planing Department.

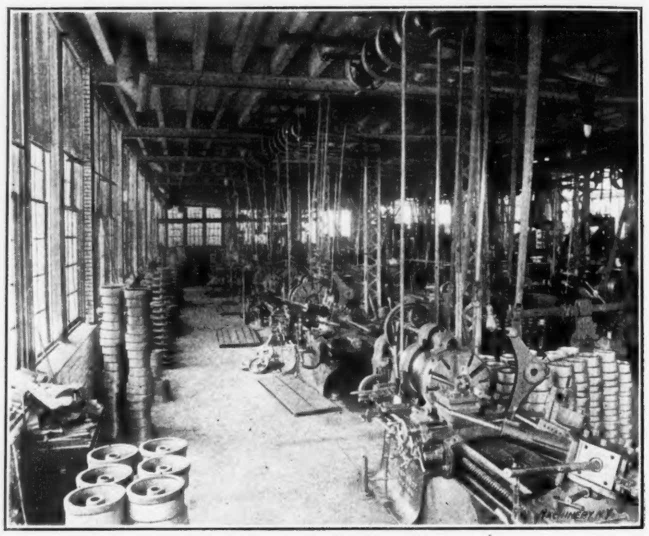


Fig. 6. Heavy Lathe Department.

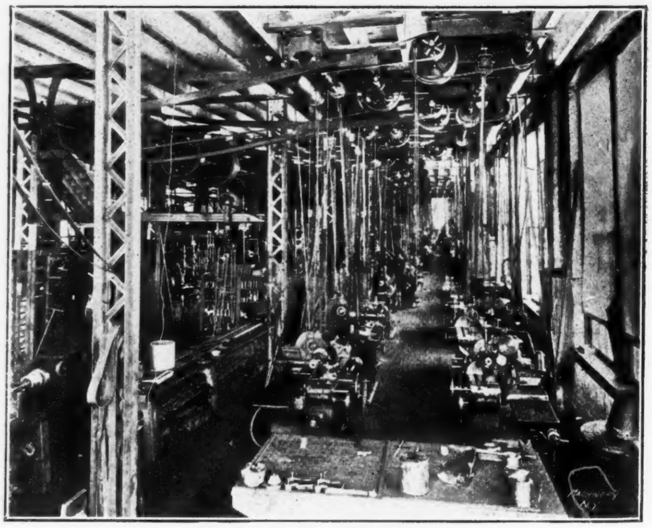


Fig. 7. Grinding Department.

The first floor of shop No. 2 is used for heavy work, the planers being located in a longitudinal line in the middle of the room, at the edge of the space covered by the crane, leaving the main part of the floor beneath clear for heavy parts of machines in process of construction. Beneath the gallery are located heavy lathes and turret lathes, and a vertical boring

mill, and along the wall on the other side of the clear space are several radial drills and a floor-plate boring mill.

This floor is illustrated in two views, Figs. 5 and 6. In the gallery of this building is the vise department arranged for fitting up and assembling smaller mechanisms and parts of machines.

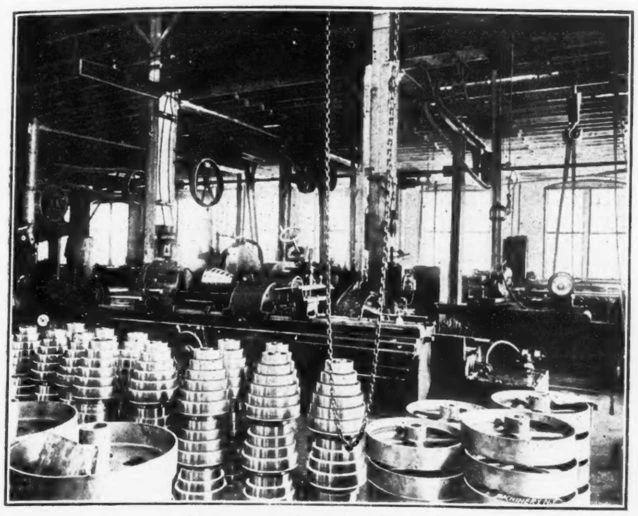


Fig. 8. Grinding Cone Pulleys.

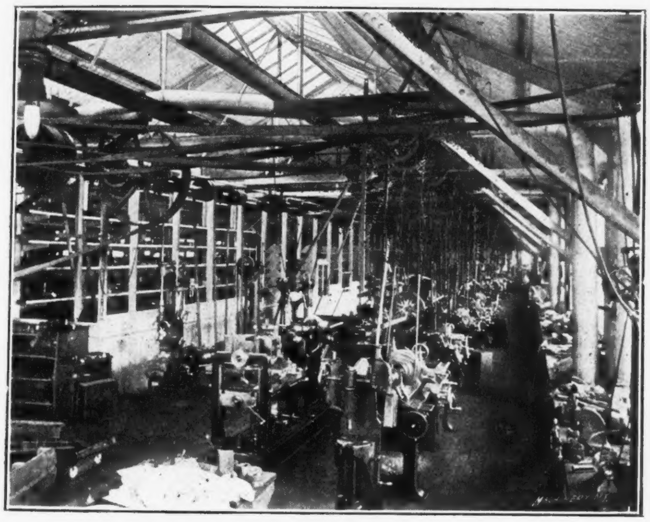


Fig. 9. Tool-room.

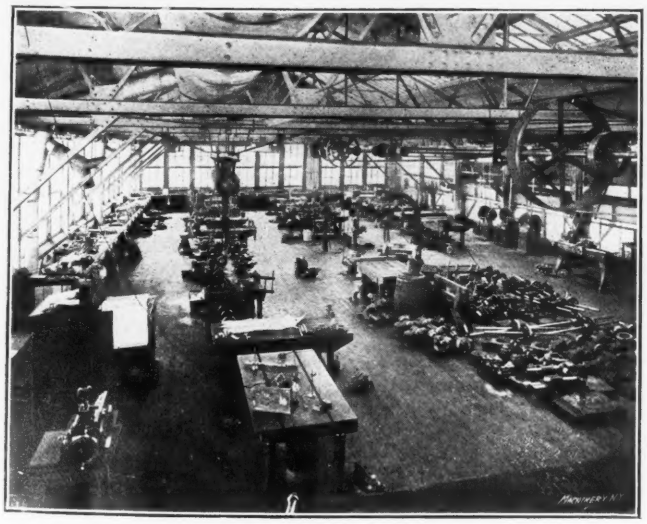


Fig. 10. Vise Department.

Another building about 40 x 160 feet is used for the painting, the blacksmith shop, and steel stock-room, and the room under the offices is fitted up for storage of finished stock.

One of the manufacturing methods worthy of note in this shop is the method of planing. All beds, swivel-plates, and carriages are roughed out on one set of planers, and finished on another set, the latter being always kept in perfect alignment and used only for finishing. While this practise necessitates additional handling, it has been found that the saving of time required in scraping to proof-plates is so much decreased as to offset the additional handling many times. It was found that when the same planer was used for both roughing and finishing, it was subjected to such severe strains that it was impossible to keep it in good condition.

As is natural in a shop manufacturing grinders, everything is machine ground, both internally and externally, where there is any advantage to be gained, either in time, accuracy or finish. All bushings are internally ground, most drums are finished by grinding, and some cast iron drums are finished from the rough. The most novel and extensive application of grinding is found in the handling of pulleys. These are practically all crowned and finished on the grinder, two and sometimes three machines being utilized for this work most of the

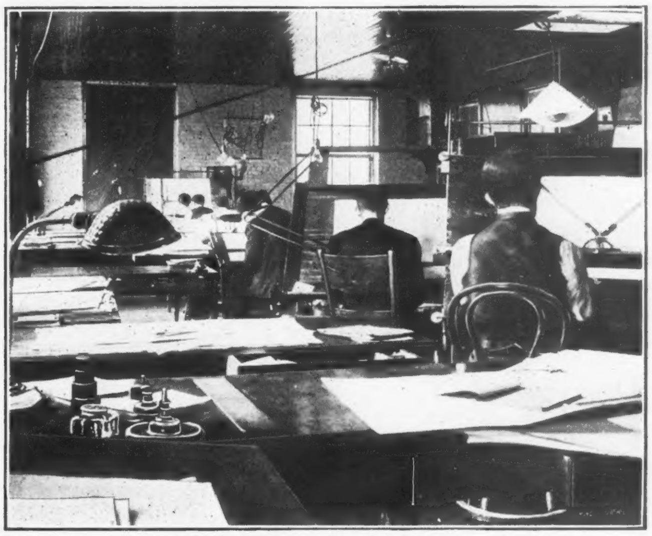


Fig. 11. Corner of Drafting Room.

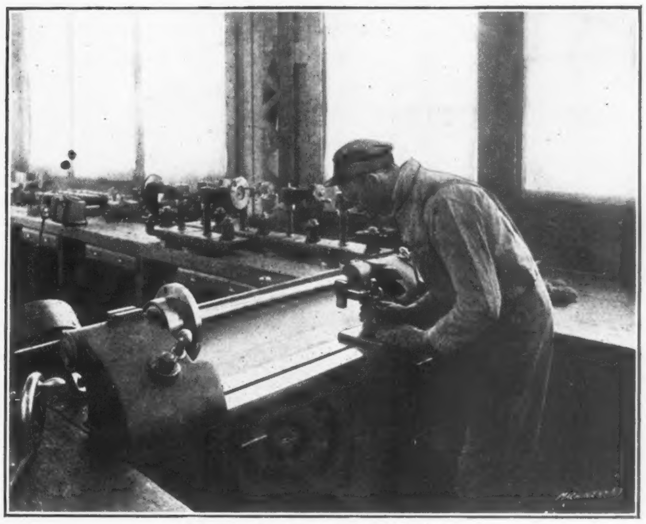


Fig. 12. Lining-up the Tail-stock.

time. Both single and cone pulleys are finished in this manner, some of the former with faces as wide as 4¼ inches. All are finished with a radial crown from 1/16 to ¼ inch larger in diameter at the center than at the edge of the crown, according to the width of the face, the faces having been previously rough-turned to within 1/64 inch of the required size.

This grinding is accomplished by using a wheel with a width slightly greater than the face of the pulley, and sinking straight in without any traverse of the wheel with relation to the work. The wheel is previously given a concave face of a radius suitable for the pulley to be crowned, by means of a radial truing device which is in position on the machine in the photograph, Fig. 8. This device comprises simply an open box-shaped base, fastened to the swivel table of the grinder, and provided with a number of holes located about 2 inches apart. Pivoted upon this base is a long arm also provided with

a number of holes, and having a diamond set at one end. By changing the location of the pivoting point, any suitable radius may be obtained.

The following figures on this work, taken without any special preparation, and representing average results, will be found interesting to compare with lathe work. A pulley 11 inches diameter, 4¼ inches face, about ⅛ inch crown, roughed out to within 1/64 inch of the required size, was ground in eight minutes, exclusive of the time of putting on mandrel. The work surface speed was about 5 feet, and the wheel speed about 5,000 feet per minute. While this operation required considerable power behind the machine, it was not very much more than that required for crowning on the lathe with a wide-faced tool, and the saving in time more than pays for the little extra power consumed. Another pulley 18 inches diameter by 3 inches face was ground in 7 minutes. A cone pulley of three steps, 17⅛, 16 3-16, and 15 inches diameters, all 3⅛ inches face, was ground complete in 20 minutes.

In all these cases the work was finished on the grinder in the time indicated with a finish plenty good enough for the purposes of a pulley.

In some experimental work done here recently results were obtained which would call for considerable effort on the part of the lathe to compete in the way of roughing out stock. Some cast iron drums 3⅛ inches diameter by 19½ inches long, were rough ground, ⅛ inch being removed in two cuts, once up and back, depth of cut 1/32 inch, on an average of 3 minutes each. This is equivalent to a reduction of about 4 cubic inches of metal per minute, and was exceeded in some cases.

Thus it is plain that the growth of the grinding idea has included work that only a few years ago would have been regarded as purely a lathe operation in all machine shops. The old idea that grinding was to be regarded as a finishing operation, to be used only where great precision was required, was exploded some years ago, but it takes a long time for the idea to become generally accepted. The natural improvement in grinding machinery will likely make these machines still more formidable competitors of other machine tools, as time passes.

* * *

CAST THREAD FITTINGS.

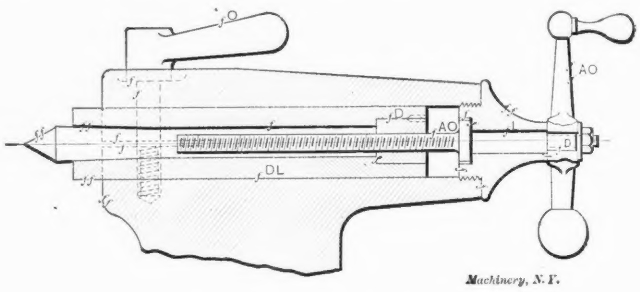
In a paper read at the annual convention of the American Foundrymen's Association held at Philadelphia, Pa., in May, Mr. Henry B. Cutter, of Seneca Falls, N. Y., stated that the principle and method of making gray iron castings with threads cast in them was developed by George Cowing, of Cleveland, Ohio, about 1878. The development of such castings was coincident with that of the pump industry, in which Cowing & Co., Seneca Falls, N. Y., were leading factors. This company employed the method of casting the threads on parts which had to be screwed together, until the practical abandonment of the business. Since the organization of the Cast Thread Fitting and Foundry Co., the idea has been carried to a much higher development. Recent tests made with cast thread fittings screwed together with wrought iron pipe having standard cut threads showed no indication of leak under a pressure of 900 pounds to the square inch, although nothing else than lubricating oil was used on the threads in screwing them together. The method pursued in making these fittings does not involve the use of chills as has been erroneously asserted, but does require the use of seamless sand cores formed without fin or rib as inevitably would be the case if made in sections in a cored box. The threads of these seamless cores are formed in sand by special devices, which cut a thread in the sand. The dies of the thread forming device are made of high grade steel and wear very slowly. When once made to standard gage, they produce thousands of seamless thread cores without appreciable variation in pitch or size, and perfectly round. These seamless thread cores are then joined with the ordinary plain or body cores by arbors, and are placed in the mold the same as ordinary cores. Special iron mixtures and fine sand are employed to produce a clean, sharp thread in the castings. This system has been developed so that the threads and castings which come at opposite ends of the fittings will be in perfect alignment.

INDICATING FINISHED SURFACES.

C. T.

The accompanying line cut shows a simple and convenient system of finishing marks which has been in use for several years. It will be noticed that the usual f is the predominating character, with the addition of a small letter at the right, this letter denoting the fit desired in the piece on which it may be placed. This exponent, as it were, has not been chosen so much because it would suggest the character of the fit, but rather for the ease with which it may be made on the drawing, that is, with one stroke of the pen. In the design of special machinery, where the workmen have no past experience to guide them, these marks have saved, to the draftsman, any small and yet important questions as to fit, finish and quality of finish, necessary.

On detail drawings, something to show the fit is essential to make a complete working drawing, and on more or less assembled drawings some marks of this nature are of no less importance, for each man having occasion to use the drawing



Indication of Finished Surfaces.

can tell at a glance what should be a running fit, what a driving fit, what ordinary machine finish, and what polished. The allowance for the fit is preferably made in the holes, the parts fitting them being machined to the exact figure given. This, however, is unimportant, as the allowance could be made on the parts fitting the holes, according to the individual shop practise.

The table below will give a clearer idea of the application and value of the marks. If each man is given a blue-print or card of the finish characters along with the first drawing on which they are used, no further trouble is found in making the men accustomed to their use.

TABLE OF FINISHING MARKS.

The following marks will be used on drawings to indicate the finish and fits required:

f, machine finish.
ff, machine finish, (polished).
f^{O}, hand finish only.
f^{S}, forcing fit, − 0.002 for first inch and 0.001 each additional inch.
f^{D}, driving fit, − 0.001 for first inch and 0.0005 each additional inch.
f^{DS}, easy driving fit; exact size.
f^{L}, running fit, + 0.001 for first inch and 0.001 each additional inch.
f^{1}, finish exactly to size.
$G\ D$, gear distance.
+ or −, allowance between shoulders.
—► key drives this way.
f^{AO}, finish all over.

All allowance for fit to be made in holes. Shafts to given dimensions. All dimensions in inches up to 8 feet.

* * *

The *Elektrotechnischer Anzeiger* gives the following method of sharpening files and other similar tools. The file is connected with the positive pole of a battery consisting of twelve Bunsen cells, and is then placed in a bath made up of 40 parts of sulphuric acid and 1,000 parts of water. The negative electrode is of copper wire wound in spiral form around the file, but not touching it. The action takes about ten minutes. It is said that files treated in this way appear to be quite new, and are satisfactory in use.

MAKING AN ACCURATE ARBOR.

HARRY A. S. HOWARTH.*

Herewith is described a job which a tool-maker sometimes meets with. It would be well if problems of this kind were better understood by the beginners and by those who do not give much thought to their work. Fig. 1 shows an arbor which it is essential to have as perfect as possible. The threaded hole *B C* should run perfectly true with the outside taper, and with the end *E*. The threaded hole is deep, and is to be sized with a tap so as to be of a standard dimension. In order that those of less experience may understand thoroughly the processes of making this arbor, the operations will be described briefly in detail.

Cut off a piece of stock to length, allowing for facing. Face both ends in a chuck to nearly the finished length; then center both ends carefully. Rough turn the arbor, and turn the end *E* true and smooth to a size slightly over its finished size. Place the steady-rest in position so as to guide the arbor at *S S*, as shown in Fig. 1, *A* being the spindle center. The dog

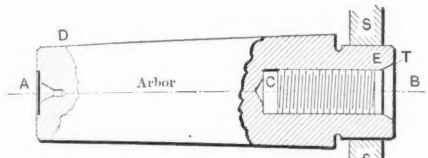


Fig. 1

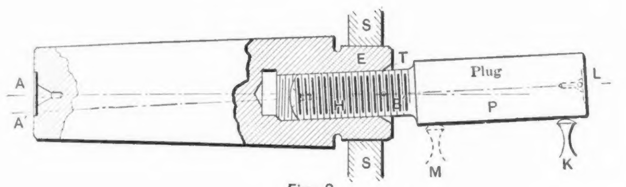


Fig. 2

Fig. 3

Making an Accurate Arbor.

at *D* should be strapped to the face-plate so as to hold the arbor tightly to the center. Remove the tail-center, and, after securing the steady-rest, run the tail-center up to its place again and examine the center in the end *E* of the arbor to make sure that the steady-rest has not sprung the arbor out of line. If everything seems all right, push back the tail-stock, and proceed to drill and bore the hole *B C*. To get this perfectly true, it should be finished with very light cuts at a slow speed. The size of the hole should be slightly larger than the bottom diameter of the thread of the tap with which the hole is to be sized. It is difficult to fit a screw to a hole that has a full V thread. After boring the hole *B C*, recess its end *C* as shown, enlarging it to a little more than the full diameter of the thread to be cut. This makes a clearance space for the thread tool when cutting the thread. Then enlarge the end *E*, and bore the taper *T* carefully so that it can be used as a center later on.

The thread shown in Fig. 1 is a right-hand thread, and it should be cut carefully, making sure that the thread tool is set so as to cut a symmetrical thread. During the last few cuts the work should revolve slowly, and light cuts should be taken. Be sure the tool is hard and keen. After cutting the thread nearly to size, finish the hole with the taps, first using a blunt taper tap, next a plug, and last a bottoming tap. When but one tap is used it should be a plug tap with an amount of taper depending on the depth of full thread necessary in the hole. The usual chance for error in a job of this kind lies in the tapping of the hole. If not carefully done, the tap gets started out of true, and when finished, the thread in the hole is out of line with the center *A*. This error is shown exaggerated in Fig. 2. It is essential to test the arbor to discover the amount of error, if any, in its alignment. To do this, turn and thread on centers a plug that will fit the tapped hole firmly, without bottoming in the hole. The diameter of the threaded portion of this plug should be less than the diameter of the tap which was used to finish the thread in the arbor. Use another lathe in making this plug, so as to avoid disturbing the setting of the arbor. Screw this plug into the hole *H*, then revolve the arbor and plug slowly. The arbor is still in the steady-rest. Place an indicator against the end of the plug at *K*. The number of thousandths inch the end of the plug is out of true is shown on the indicator. The eccentricity of the center *L* of the plug is half the oscillation of the indicator pointer.

Referring to the diagram, Fig. 3, showing center lines only, the distance *L B'* is the eccentricity of the plug at *L*. The line *A B B'* is the center-line of the arbor, and *A' B L* is the center-line of the tapped hole. It is evident that if the center *A* coincided with *A'* the arbor would be perfect. But we find in our case that the indicator shows an eccentricity of 0.002 inch when placed at *K*. This means that the oscillation of the pointer is 0.004 inch. Suppose that the center-lines intersect at a point *B*. This point can be determined approximately by proportion, after making one more test with the indicator. Move the indicator to point *M*, and the oscillation at this point will be more or less than at *K*. The point *B* is located where the oscillation would cease. In Fig. 3 it is shown near the end of the arbor, though it might be far outside. Produce the line *B L* to *A'*; then *A'* would be the correct position for the center *A*. The distance *A A'* is the eccentricity between the center *A* and its correct position *A'*. This distance may be determined by proportion.

$$A\,A' \div L\,B' = A\,B \div B\,B'$$

$$A\,A' = \frac{L\,B' \times A\,B}{B\,B'}$$

Suppose $A\,B = 6$ inches and $B\,B' = 2$ inches, and that, as we assumed before, $L\,B' = 0.002$ inch. Then

$$A\,A' = \frac{0.002 \times 6}{2} = 0.006 \text{ inch.}$$

Hence, if center *A* be drawn toward *A'* 0.006 inch, it will be in its proper place, *i. e.*, at *A'*.

After correcting our arbor, as suggested above, it should again be tested. This time, however, remove the steady-rest and run the tail-center up to the end of the plug at *L*. Rotate the arbor and plug on the centers *A'* and *L*, and test by placing the indicator at *M*. If we still find that the indicator shows an error, make the necessary correction by slightly scraping the center *A'*. When correct, no error should be shown by the indicator.

Now that we are assured that our centers are right, we can proceed to finish the arbor. If the plug is stiff enough, finish turn the arbor on the centers *A'* and *L*. If the plug is frail, simply use it to take a light cut on the end *E*. Then place the steady-rest on this new surface of *E*, and remove the plug. Bore carefully the taper shown at *T*. Remove the steady-rest and mount the arbor on its own centers *A'* and *B*, the latter being formed by the taper *T*. Then, finally, finish the arbor on the outside.

A slight variation from the above method is advisable when the threaded hole is large in proportion to the rest of the arbor. In this case the plug should be made in a chuck, and the arbor screwed onto it, and the center *A'* determined by spotting.

* * *

Our readers will remember that in our February issue we told something of the pathetic wanderings of an item of interest relating to the strength of grindstones, which was originally published in these columns, but which has since appeared in technical papers all over the globe, and been credited to almost every one under the sun except ourselves. It is with a feeling of sadness, and yet with an inner sense that perhaps it is for the best, that we report that this little item has at last reached a resting place in one of our contemporaries, in a column which is appropriately called the "Scrap Heap." Again we say "It is well."

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REMARKS ON THE MAKING OF HAND TAPS.—2.

ERIK OBERG.

Change of Pitch in Hardening.

As is well-known, the pitch of a tap as well as its diameter will change in hardening, the pitch as a rule becoming shorter and the diameter larger. This tendency of change can be minimized by slow and even heating, combined with hardening at as low a heat as is possible for obtaining the desired results in the tap, but the tendency can never be fully overcome. For this reason it is necessary to cut the thread of taps on lathes having leadscrews slightly longer in the pitch than the standard. The tap will then also have a pitch slightly in excess of the standard before hardening, and if the excess length is properly selected, the tap will have a nearly correct

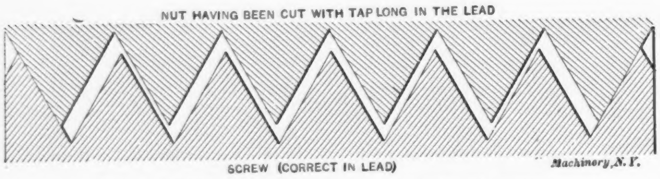

Fig. 1. Effect of Difference in Lead in Nut and Screw.

pitch after hardening. The amount that the pitch should be longer before hardening varies, of course, according to the makes and grades of steel. To give definite rules in this matter would be impossible, most particularly so, because the result of hardening may not always be shrinkage in the length of the piece to be hardened. Practical experiments have proved that in some cases, although rare, even when working with a most uniform grade of steel and handling it with the utmost care, there is no sure way of telling whether the result will be shrinkage or expansion. However, it has been found that most kinds of steel have an invariable tendency to contract lengthwise when hardened, and if this contraction has been found to be within certain limits in a few experiments, the steel may be fairly well depended upon to vary in the same way in so great a number of cases as to permit disconsidering those in which unexpected results are obtained. It is of interest to note, however, that exceptional cases have been observed where different parts of the same pieces have shown considerable difference in the amount of shrinkage.

While, as stated before, definite rules cannot be laid down, it may be given as a guide that most steels have an average shrinkage of from 0.016 to 0.020 inch per foot, when the ratio between the diameter and the length of the work does not exceed, say, 1 to 10. When, however, the threaded piece is very long compared with the diameter, as for instance in stay-bolt taps, the contraction is proportionally greater.

Special Lead Screw for Tap Threading.

The most common amount to cut hand taps long in the lead in one foot is about 0.018 inch. Stay-bolt taps and taps of a similar kind are often cut from 0.030 to 0.034 inch long in the lead in one foot. The lathes for threading taps should therefore be provided with special leadscrews. The ratio of the change gears for cutting these leadscrews is found from the formula

$$R = \frac{l \times r\ (12 + a)}{12n}$$

which was published in MACHINERY in April, 1905. In this formula

R = ratio of change gears to cut the thread a certain amount, a, longer in one foot than the same number of threads regularly pitched,

l = threads per inch on leadscrew of lathe,

r = ratio of gears in head of lathe,

a = amount thread is longer in one foot than the same number of threads would be regularly pitched, and

n = nominal number of threads per inch of work to be threaded.

If we assume that we wish to cut a leadscrew which is 0.018 inch long in the lead in one foot, and that the nominal number of threads per inch in this leadscrew is to be 8, that the correct leadscrew in the lathe used for cutting the screw is 6 threads per inch, and finally, that the ratio of the gearing in the head-stock of the lathe used for cutting is 2, then our ratio of change gears, necessary to cut the leadscrew in question, would be

$$\frac{6 \times 2\ (12 + 0.018)}{12 \times 8} = 1.50225.$$

The gears used must be found by trial to correspond to this ratio. These trials are more or less lengthy, but no definite rule can be given except the one for finding the ratio according to the formula presented.

Provision for Difference in Lead of Tap and Screw.

While the method of using a leadscrew which is cut a certain amount long in the lead will prevent any serious deviations, the lead of the tap can, however, not be depended on to be exactly correct, even when the precautions referred to are taken, although it will be within very close limits. If the tap is long in the lead after hardening, the nut tapped will, of course, also be long in the lead, and will not fit a standard screw correctly. The resulting fit is shown exaggerated in Fig. 1. As this difficulty cannot be eliminated in any way, the only thing possible to do to arrange so that a screw of standard diameter and correct lead will go into a nut of incorrect lead, is to make the diameter of the nut, and consequently the tap for tapping the nut, a certain amount oversize, as is

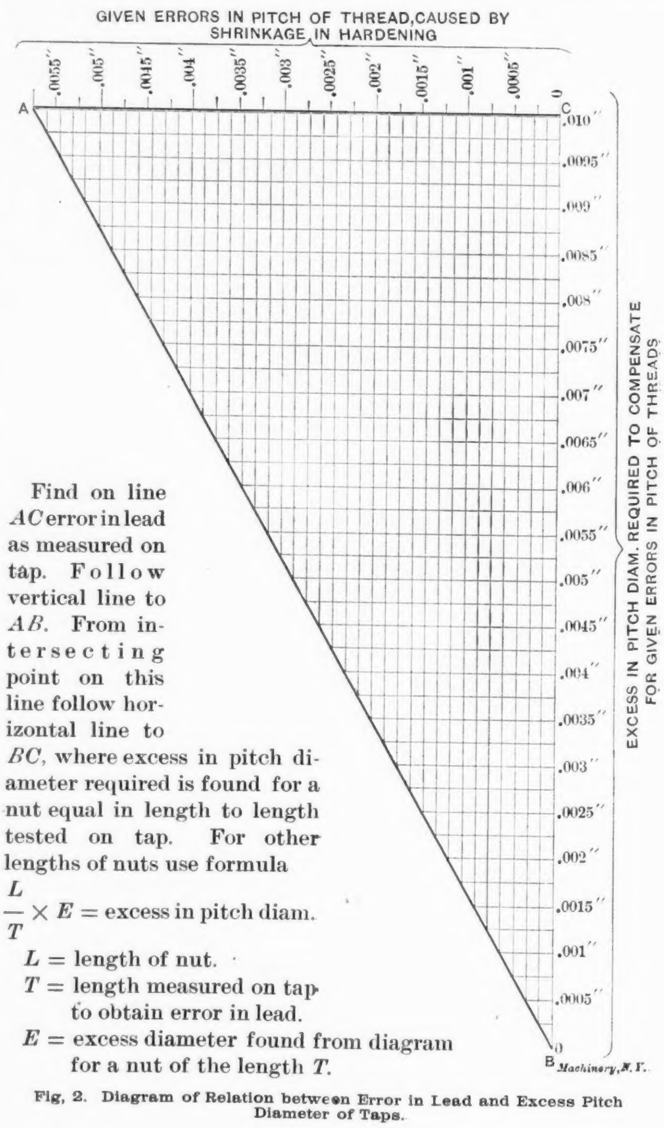

Fig. 2. Diagram of Relation between Error in Lead and Excess Pitch Diameter of Taps.

shown in Fig. 1. This amount depends upon the length of the nut to be tapped, and upon the unavoidable error in the lead of the tap. As these quantities are difficult to settle upon, particularly when making taps for general purposes in great quantities, some standard figures must be assumed which would fill the requirements in all ordinary cases. In Table III. is given the amount of oversize near which the angle diameter of hand taps ought to measure after hardening. In

other words, the angle diameter must be between the standard angle diameter and the standard + the limits of oversize stated in the table, and should preferably be as near to the larger value as possible.

Swelling of Taps in Hardening.

Table III., of course, is only of value for inspecting taps after hardening, unless some data are given in regard to the amount a tap is likely to increase in diâmeter in the hardening process. If such data are given, it will make it possible to determine the angle diameter of the tap before hardening, this figure being the only one which is of use when threading the tap. It is extremely difficult to state anything with certainty in this respect. Experiments with taps made from the same kind of steel, and under the same conditions, have proved that there may be very great variations in the swelling or increase of diameter due to hardening of taps, identically the same. In Table IV. are given such values as may be considered correct for average cases. These values refer particularly to the Midvale ordinary tool steel. As the amount of oversize necessary for a tap depends on the pitch rather than upon the diameter, the data given in Table IV. should be applied to taps with standard threads only.

TABLE III. LIMITS OF OVERSIZE IN DIAMÉTER OF HAND TAPS.

Size of Tap.	Limit of Oversize.	Size of Tap.	Limit of Oversize.	Size of Tap.	Limit of Oversize.	Size of Tap.	Limit of Oversize.
1/16	0.00075	5/8	0.002	1 1/2	0.00275	2 3/4	0.004
1/8	0.001	3/4	0.00225	1 3/4	0.003	3	0.004
1/4	0.00125	7/8	0.0025	2	0.003	3 1/2	0.0045
3/8	0.0015	1	0 0025	2 1/4	0.0035	4	0.0045
1/2	0.00175	1 1/4	0.00275	2 1/2	0.0035	..	......

TABLE IV. INCREASE IN DIAMETER OF TAṔS, DUE TO HARDENING.

Diameter of Tap.	Increase Due to Hardening.	Diameter of Tap.	Increase Due to Hardening	Diameter of Tap.	Increase Due to Hardening.
1/16	....	1	0.002	2 1/2	0 003
1/8	0.00025	1 1/4	0.002	3	0.0035
1/4	0.0005	1 1/2	0.0025	3 1/2	0.0035
1/2	0.001	1 3/4	0.0025	4	0.004
3/4	0.0015	2	0.003	..	.....

The relationship between the pitch, the length of the nut, and the error in lead, on the one hand, and the excess in angle diameter on the other, is approximately expressed by the formula

$$D_2 - D_1 = \frac{ANL}{\tan 30 \text{ deg.}}$$

in which formula

D_1 = the theoretical angle diameter,

D_2 = the actual diameter wanted in the tap to compensate for the error in the lead,

A = the error in lead per each thread,

N = the number of threads per inch,

L = length of nut in inches.

Diagram of Relation between Error in Lead and Excess Diameter.

The relationship expressed by the formula above is shown in the diagram in Fig. 2. This diagram gives the excess in angle diameter required, over the standard angle diameter in taps, to compensate for given errors in the pitch of the thread due to shrinkage in hardening. If the error in the pitch in a certain length T is given, the diagram will give the excess in pitch diameter necessary to compensate for this error, assuming that the length of the nut to be tapped equals T. If the length of the nut to be tapped does not equal T, the amount of excess in pitch diameter required is obtained from the formula

$$\frac{L}{T} \times E = \text{excess in pitch diameter necessary to permit a correct screw to go into the tapped nut.}$$

In this formula L = length of nut to be tapped, and E = the excess in pitch diameter required for a piece to be tapped, the length of which is T, this excess being found by means of the diagram, Fig. 2.

In order to make perfectly clear the use of the diagram and the formula given, let us assume that the given error in the pitch of the thread in a length of 3 inches is 0.001 inch. Suppose the nut to be tapped is 1¼ inch long. Then $T = 3$; $L = 1\frac{1}{4}$; $E = 0.00175$ (found from the diagram in manner as will be immediately explained), and according to our formula

$$\frac{1\frac{1}{4}}{3} \times 0.00175 = 0.00075 \text{ inch (approximately)} = \text{excess in angle diameter required.}$$

The value of E is found from the diagram by finding 0.001 on the horizontal line AC; then follow the vertical line from 0.001 to the line AB; from the intersecting point on this line follow the horizontal line to BC, and read off the nearest graduation on the scale on this line. The value obtained is E, or the excess in angle diameter required, provided the length of thread in which the error in lead is measured equals the length of the nut. Otherwise the amount of excess is found by the formula previously given, in manner as has already been explained.

It is common that the length of nut which is taken as basis for various taps, when they are to be used on general work, is assumed to equal the diameter of the tap. It is evident, however, that this will be correct only for taps with standard threads, because when threads finer than standard are used for a certain diameter, the length of the nut is usually shorter. The excess in angle diameter should therefore properly be determined rather by the pitch than by the diameter of the tap. This is done by several firms when inspecting taps made for them by outside concerns.

The Westinghouse Electric and Manufacturing Company makes use of a formula:

$$\text{Excess in angle diameter} = \sqrt{\text{pitch}} \times 0.01.$$

By means of this formula values a trifle larger than those given for limits of oversize in Table III. are obtained. In this formula the excess angle diameter is made directly dependent upon the pitch of the thread. In Table V. the values of the excess for a number of pitches are given. The corresponding diameters of United States standard screws are also stated. This will permit comparison to be readily made with the values in Table III. It must be remembered that these values refer to the sizes of the taps after they are hardened.

TABLE V. LIMITS OF OVERSIZE IN DIAMETERS OF HAND TAPS.

No. of Threads per inch.	Corresponding Diameter, U. S. Standard.	Limit of Oversize = $\sqrt{\text{pitch}} \times 0.01$	No. of Threads per inch.	Corresponding Diameter, U. S. Standard.	Limit of Oversize = $\sqrt{\text{pitch}} \times 0.01$
3	3 3/4–4	0.0058	18	5/16	0.0024
4	2 5/8–2 3/4	0.0050	20	1/4	0.0022
5	1 3/4–1 7/8	0.0045	22	..	0 0021
6	1 5/8–1 1/2	0.0041	24	..	0.0020
7	1 1/8–1 1/4	0.0038	26	..	0.0020
8	1	0.0035	28	7/32	0.0019
9	7/8	0.0035	30	..	0.0018
10	3/4	0.0032	32	3/16	0.0018
11	5/8	0.0030	36	5/32	0.0017
12	9/16	0.0029	40	1/8	0.0016
13	1/2	0.0028	50	3/32	0.0014
14	7/16	0.0027	56	..	0 0013
16	3/8	0.0025	64	1/16	0.0012

Hardening Taps.

As mentioned before, the amount that a tap will alter its dimensions in hardening depends greatly upon the manner in which it is hardened; the heating must be made evenly throughout the tap, and it should be heated slowly; the water used for dipping should not be very cold; the tap, when dipped, should be held in a vertical position. The amounts given in the preceding tables are those resulting from hardening by experienced men in ordinary manufacturing of taps. But it must be clearly understood that the rules for hardening are all very indefinite; to say, heat slowly and uniformly, is very easy, but it is extremely difficult to actually do it, and experience only ever taught a man to harden a tap, or any other tool, right. Mr. E. R. Markham in MACHINERY, May, 1904, describes a method of hardening taps by means of which, he claims, the original pitch and diametrical measurements can be maintained. This method is termed "pack hardening," and is undoubtedly superior to the ordinary method.

When hardening in the ordinary way, however, the tap is heated to the greatest advantage in a crucible of molten lead, heated to a red heat. There is some difficulty experienced, when heating taps in this manner, from the lead sticking to the tap. While there are a great many toolmakers who do not take any precautions to prevent this, it may be avoided by dipping the tap in a mixture of one part charred leather, one and one-half part fine flour, and two parts fine salt, all thoroughly mixed while dry, and converted into a fluid by slowly adding water until the mixture has the consistency of varnish. After dipping the tap in this mixture, it should be permitted to dry before being dipped in the hot lead.

In drawing the temper, it is evident that a certain temperature can hardly be settled upon, inasmuch as various kinds of steel do not require to be drawn to exactly the same degree. It may be said as a general rule that temperatures varying from 430 to 460 degrees F. will prove correct; the lower temperature mentioned is commonly employed for the oil baths used for drawing the temper in manufacturing plants. If any preference should be given to a definite temperature, it is best to make it a rule to draw large taps to 430 degrees F., and smaller ones, say up to 7/16 inch, to 460 degrees F.

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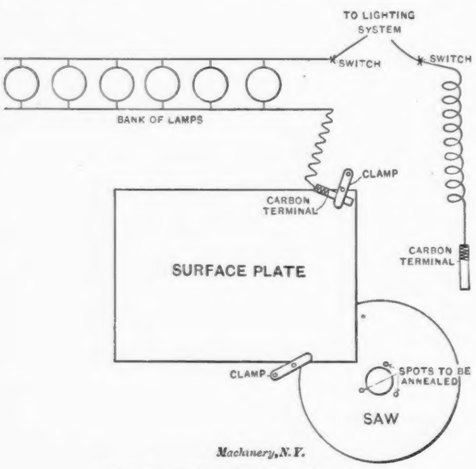
SAW ANNEALING BY ELECTRIC ARC.

A contributor to the *Electrical World* describes how in a simple manner the electric arc may be utilized for annealing the center of a circular saw. For a certain milling operation it was necessary to use a 4-inch saw, 1/16 inch thick, so close to a projection on the work that it could not be supported on more than one side. A special arbor was made with a shoulder, and the saw was soldered in place. The heat of the solder,



Saw Annealing by Electric Arc.

however, made the saw buckle, and it broke loose after milling a few pieces. It was then decided to anneal the center of the saw, and fasten it to the end of the arbor with button-head screws. The device shown in the cut was used for the annealing. This device consisted of two pieces of arc light carbon connected up to the lighting system, which was 110-volt direct current, with six 16-candlepower lamps arranged so that one or more could be put in the circuit for resistance. The spots to be annealed were marked on the saw, and it was then clamped to one edge of a small surface plate. One of the carbon terminals was also clamped to the surface plate, and after turning on the current, the other carbon was held just far enough from the spot to be annealed to cause a good arc. This was continued until the spot was judged to be hot enough, and then the other spots were treated in the same manner. The result was so successful that the saw was easily drilled and countersunk at the annealed spots, and the screws put in flush with the side of the saw.

* * *

The report of the State Board of Railway Commissioners, in regard to the wreck of the electric train on the New York Central Railroad on February 16, in which twenty-four persons were killed, states that the direct cause of the wreck was a weak track. The Board, however, does not place the responsibility on any certain official, or on any group of officials.

GUARDS ON MACHINE TOOLS.

T. S. BENTLEY.*

There has been a growing recognition during recent years of the need for special precautions to lessen the risk of accidents due to machinery in motion. The danger to life and limb, from this cause, has greatly increased with the general adoption of mechanical appliances, in all departments of industry, in place of hand labor such as was formerly employed. While the community, as a whole, has benefited by the change in methods, it has been in too many cases at the cost of the individual, who has either found his occupation gone in consequence of the improved means of doing his work, or, having adapted himself to the new conditions, has found himself exposed to dangers from which he was formerly free.

While it is undoubtedly true that the majority of accidents from machinery ought not to occur—being principally due to carelessness or lack of skill on the part of the operator—there is still a large percentage that cannot be imputed to either negligence or want of skill, but must be admitted to be the result of pure misadventure. Now, whatever may be the precise cause of an accident, the result is pretty much the same; and it is practically impossible to discriminate between those in which the injured person is more or less culpable, and those in which he is purely the victim of misfortune.

In Great Britain—and indeed in most other countries also—the responsibility of the machinery owner is being more and more insisted upon, and, under existing employers' liability acts, he is liable in almost all cases to make compensation to the injured person. In many cases this amounts to a considerable sum, and the matter therefore is one which must be seriously faced. Of course this liability, like most others, is now a subject for insurance, and this is being largely resorted to. The premiums that are charged naturally vary with the probable risk, as far as it can be gaged, and the insurance societies keep a sharp lookout to see that all precautions are taken to reduce the dangers of accidents to a minimum. This means that the machinery owner has to satisfy not only the requirements of the government inspectors, but also those of the man representing the insurance company, which has a pecuniary interest in the safety of his plant. The result of all this is to make owners of machinery increasingly anxious that, as far as is possible, efficient protection shall be provided for all parts of the various machines which may be likely to inflict injury on anyone coming in contact with them.

The fitting of guards, as an afterthought, to machines whose designers have omitted them, is always a costly, and seldom a satisfactory, undertaking. The recognition of this fact makes buyers more and more insistent that suitable guards shall be provided by the makers of the machine, wherever necessary. So much is this the case that, other things being equal, a properly guarded tool will invariably be chosen in preference to one equally good in all other respects, but in which this matter has received less satisfactory treatment. Machine tool builders have largely responded to the demand thus produced, and all the most up-to-date firms are now furnishing their machines fitted with neat and effective guards, well-designed and altogether superior to the sheet iron makeshifts which have been generally employed for so long. There can be no question as to the fact that the makers of a machine are the right persons to design and fit proper guards for it. In the first place, it is often necessary either to modify the framework of the machine, so that part of it forms a portion of the guard, or to provide suitable lugs, etc., for the attachment of the guards when they are made in the form of additional fixtures.

While there is some difference of opinion as to how much guarding is really requisite, the general opinion is in favor of complete protection, not only of toothed gearing, but also of rapidly revolving wheels whose spokes might conceivably inflict injury. This latter is not considered indispensable by some inspectors, while others, on the contrary, insist upon it. As to gearing, this should be completely covered in. The little apologies for guards which some makers fit, merely across the entering teeth of a pair of wheels, are wholly

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inadequate. Almost as much damage can be done between the moving teeth and the fixed guard as between the teeth themselves, if left bare. The back gears of lathes are now generally guarded, but the change gears should also be covered, and this is not always done. The same remark applies to the bevel gears which drive the spindle of an ordinary drill press, and in many cases the feed gears are insufficiently protected. In all cases of doubt it is well to do too much rather than too little, and in the long run this policy will be found to pay.

In designing guards, several different requirements must be kept in mind. They must be effective, and make injury practically impossible; otherwise they are worse than useless, in that they inspire a confidence that is delusive and misplaced. They must also be so arranged that they do not impair the convenience or efficiency of the machine they protect. If this is not so, they will be discarded in many cases by workmen, who, especially if on piece-work, will prefer to run a vague and incalculable risk, rather than put up with a certain and exasperating hindrance.

The guards must be so arranged that all necessary adjustments can be readily made, and oiling or examination of the parts can be easily effected. This sounds such an obvious requirement that it may seem needless to mention it, but in reality it is not always properly met. I have known cases where this matter has been so lost sight of that the guards, when in place, entirely prevented inspection, or even effective oiling, of some of the working parts; and, to aggravate the difficulty, they could not be removed till a great amount of gearing and mechanism had been stripped from the machine. Of course, these are extreme cases and doubtless due to the fact that the design of the guards has been considered an unimportant matter, and left to some junior draftsman who did not thoroughly understand the working of the machine, but they serve to show that a word or two on this aspect of the question is not out of place, or as unnecessary as it may seem to be.

There is one other consideration that is not without importance. This is the matter of appearance. A machine tool is, of course, built primarily for use, and if excellent service is obtained from it, many minor faults will be forgiven it by the man who is responsible for getting the work out. It often happens, however, that this man is so busy, and of such vital importance *in the shop*, that he cannot be spared to act as purchasing agent. Thus the man who actually places the orders is usually one of the managers of the firm, or else a "buyer." In either case he is not likely to be so intimately in touch with the practical details of workshop routine as to be guided by the same considerations as the superintendent would be. The "buyer" usually looks first at price, and is ever anxious to justify his title by securing bargains. The manager, being probably more closely connected with the commercial rather than the manufacturing end of the firm, is apt to base his judgment on general appearance instead of on such matters of detail as the shop man would look for. This makes it additionally important that the guarding should be well carried out, as the manager would have to meet any possible claims for compensation, and will not forget that fact. Besides, the appearance of a machine is rendered far more attractive by carefully designed and well fitted guards, and the natural inference is that makers who duly attend to these last finishing touches will have made very sure that everything else is as it should be.

The conditions which we have reviewed are affecting all the markets of the world. They vary somewhat in degree, but cannot be ignored. No longer are guards mere trivial details, or fanciful additions; they are now essential parts of the machine, and as such can hardly receive too much attention from makers who are keenly alive to their own interests, and who intelligently read the signs of the times.

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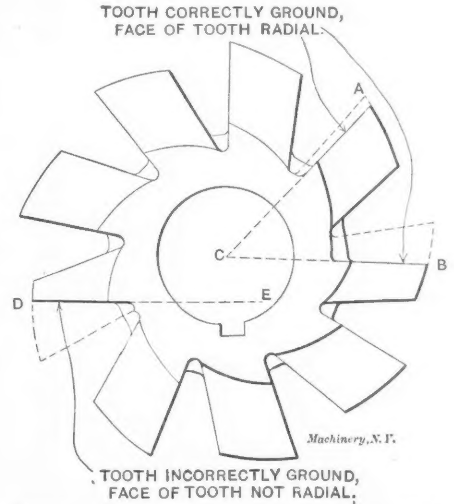
The statement that the tension per unit of cross-section area of a thin spherical shell subjected to internal pressure, is one-half as great as in a thin cylindrical shell of the same diameter and thickness, is true only when the strengthening effect of the heads of the cylinder is ignored.

IMPORTANCE OF GRINDING GEAR-CUTTER TEETH RADIALLY.

A leaflet, calling attention to the need of grinding gear-cutter teeth radially in order to secure satisfactory results, has been issued by the Union Twist Drill Co., Athol, Mass., and from it we have reproduced the accompanying illustration for the sake of impressing some elementary instruction in the art of grinding formed cutters. The cut shows, diagramatically, how the teeth should be ground to secure the best results; it also illustrates improper grinding. The teeth *A* and *B*, of course, are ground correctly. The lines *AC* and *BC*, lying in the plane of the cutting face, are radial; that is, the faces of the teeth would pass directly through the center of the cutter, if projected to the center. Tooth *D*, however, shows an entirely different condition, and one which we regret to say, is not uncommon in gear-cutting practise. The top of



Correct and Incorrect Grinding of Gear-cutter Teeth.

the tooth was ground back faster than the base, thus throwing the face of the cutter into the plane indicated by the line *DE;* consequently the shape of the tooth space cut is distorted, and a gear with badly-shaped teeth must necessarily be produced by it.

The expression, "may be ground without changing the form," has evidently been taken too literally and without the necessary qualification that it is necessary to grind in a plane radial with the center of the cutter in order that the form shall not be changed. It is evident to anyone who will give the matter a little thought that if a gear is cut with a gear cutter having teeth ground like *D* the resulting tooth space will be too wide at the top, if the cutter is carried to the correct depth. Moreover, such a gear-cutter works badly, as the cutting faces of the teeth have a negative rake. The importance of correct grinding of all formed cutters cannot be too strongly emphasized. Unfortunately, formed cutters that can be ground without changing the form, do not always have sufficient clearance to work well with all classes of work, and if such cutters are carelessly used there will be heating and rapid wearing away of the tops of the teeth. If hard pressed and ignorant, the tendency of the grinding operator, in order to hurry the sharpening of such cutters, is to incline the wheel away from the radial plane.

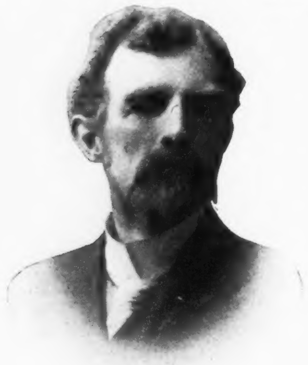
On account of this defect in formed cutters, one large concern making small tools has found it profitable in the use of certain formed cutters to make them the same as an ordinary milling cutter, with the same rake and clearance as is usual practise. When the cutters require sharpening, the teeth are ground on *top*, using a fixture which preserves the correct tooth shape. This concern has found the practise good, for the cutters are much more effective in action, and notwithstanding the increased cost of grinding, the increased efficiency more than makes up for the difference.

* * *

The 15th annual report of the General Electric Co. states that 350,000 horse-power of the Curtis turbo-generators were sold in 1906.

RECENT DEVELOPMENT OF BRITISH MACHINE TOOL INDUSTRY.

W. H. BOOTH.*



W. H. Booth.†

The status and prospects of the American machine tool trade in Great Britain is a subject that is frequently discussed on the other side, and is one that has been involved in quite a little obscurity, especially when clear ideas of the several factors involved have not prevailed. In order to understand the position and prospects, it will be well to start from the beginning and trace briefly the course of events as they have from time to time influenced the business, premising that there are two classes of American tool manufacturers, namely, those who are desirous of building up a permanent business on sound commercial lines, and those who have no particular desire to do more than take advantage of foreign markets for the purpose of unloading stocks when their home business is not brisk. There are, of course, others who blend the above two characters in varying proportions and with proportionately varying effects.

To begin from the commencement, therefore, it may be said that the American tool business in Great Britain was at one time practically limited to small tools and gages, and that machines cut no figure beyond, it may be, the high-class lathe for the use of the amateur mechanic, or perhaps an occasional drilling machine. Such, at least, is the experience of the writer, making the above statement in the entire absence of any actual statistics, and recalling the general impressions of the time referred to from his memory. As regards London, if not indeed the whole country, there were only one or two firms dealing with American tool products. Until, say, some ten years ago, the British machine tool industry had fallen gradually from its once high position into a trough of *laissez-faire* and inaptitude that rendered competition from the outside certain and inevitable, when the opportune moment should arrive, as in due time it did arrive.

Perhaps it would be unfair to blame British tool makers for the sleepy condition of non-improvement into which they allowed themselves to drift, or perhaps it should be said into which they were thrust. Secure in all markets, British products made by the aid of machine tools defied competition, and the cost of labor was ultimately gotten out of the purchaser. Under trade union rules, into a discussion of which one need not enter in this article, progress became by steady, stealthy steps virtually impossible. One man might not work two machines. He might not turn out from the one machine he did operate the half of what even the poor rating of the machine rendered possible. Of what use, therefore, was it for a machine tool maker to improve his machines by the addition of larger and wider belt pulleys, and the removal of the miserably inefficient cone pulley, which were barely competent to perform even the rating? The whole atmosphere of an average engineering workshop was irritating and depressing, the sound was of leisurely and persistent slowness, the shafting was run slowly, and the men grew slow and fat; and any really good man who could not put up with the restrictions of union rules drifted out of the trade, leaving behind only those to whom a slow, creeping life was possible. Thus the tone of everything was lowered, the demand for improved tools was reduced to a minimum, and the business of machine tool making fell into more or less disrepute.

Meantime the bicycle was being evolved, and the time was drawing near when the demand for it should become so great as to attract capital into the business. But no effort was seriously made by the British tool makers to anticipate the business, or to meet the demand when it arrived, so that, when the bicycle boom did fairly arrive, the field was open for the American tool maker, who was able to send over very large numbers of tools. The bicycle industry centered itself somewhat naturally at Coventry, where the decline of the watch trade had rendered available for the small work of the bicycle many mechanics who had been trained on the still finer work of watches. Bicycle making just suited their capacity, and the trade and prosperity of Coventry grew mightily, and still it required a revolution in the relations of employers and employed to stir up the British tool makers. This revolution followed upon the great strike of 1897. Brought about by the artificial restrictions upon output and interference by the unions with the ordinary every-day management of the workshops to such a degree as to render profitable work impossible in the face of foreign competition, there could only be two possible results of the strike or lockout. Either the British industry must have stopped, or work must have been allowed to proceed along business lines. The latter view prevailed, very much to the advantage of the employed as well as of the employer. Business at once revived, but again, as with the bicycle trade, found the British tool maker almost unable to cope with the situation. Just as a large trade had sprung up in the lighter classes of machine tools from America, so now there was a demand to be filled for heavy tools, which could hardly be met by home makers, who began to realize that the opportunity had come, which, if not taken at the flood, would have left the British machine tool trade forever in the ditch. Promptly was that opportunity grasped. It was grasped by nearly all the British makers in the usual British fashion, for it was only taken in hand when they were hopelessly beaten and discredited, when they were in the last ditch of despair. They made a great effort and began to recover trade. They were perhaps helped by the revival of business in America, which tended to restrict the too plentiful supply of American tools, but there was another factor pressing forward, again an American factor. I refer to the discovery of the Taylor-White tool steel. This steel was the logical outcome of the discovery by Mushet of the peculiar steel known by his name. The Taylor-White steel was a further step in the same direction. Its discovery practically coincided with the awakening of the British machine tool makers, the revival of trade and the increased demand for tools, with the revolution in shop practise and the removal of the worst of the restrictions upon production, and with the reduced supply of the surplus tool manufacture of America.

British tools have often been decried on account of their clumsiness. They have been alleged to possess far too much weight for the work they had to do. Probably there was some truth in this for the light cuts that had been in vogue. But the tendency to clumsiness remained. It seemed easier to design such heavy machines. And suddenly comes along a steel, to make proper use of which it was necessary wholly to redesign all tools intended to be operated with the new steel. The Sheffield steel makers entered into the question of high-speed steel with great energy. Every maker of tool steel had his brand. The use of the new steel by a few, compelled others to follow suit. Forgings could be made less close to size, so cheap was it to remove excess material. The whole practise of the shops soon became revolutionized, and the

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† W. H. Booth was born in Rochdale, in the county of Lancaster, England. He was educated in Queen Elizabeth's or Archbishop Parker's grammar school of that town and at Owen's College in Manchester, now known as Victoria University. His engineering experience was gained in the works of John Petrie & Co., builders of steam engines, water mills, pumps, boilers and general line of engineers' machinery, and in the mechanical department of the cotton factories of his father and uncle. His training was along the old-fashioned lines of the days of Rennie, Maudslay, Fairbairn, Boulton and Watt, and covers a very wide range of engineering practice, including almost every branch of modern development. His steam engineering experience was begun when steam pressures of 30 pounds per square inch were being used in engines that had been built to use only 7 pounds pressure. The safety-valve of his father's first boilers was merely a 15-foot vertical open pipe carried up the side of the factory wall and filled with water, which slopped over when the pressure got too high. He has had a wide range of engineering experience in England, New Zealand, and Australia. He is perhaps known best in America for his work in the prevention of smoke and improved coal consumption, having written and lectured extensively on this important subject. At present he is official lecturer to the London Coal Smoke Abatement Society. He is a designer of furnaces specially adapted for burning long-flaming bituminous coal so as to develop the calorific value of the fuel fully before the gases are exposed to the comparatively low temperatures of the water surface of the boiler. Notwithstanding the great progress made in engineering practice generally, Mr. Booth finds that the apathy of most engineers in regard to fuel burning is appalling. He finds practices in vogue that were condemned by his father years ago as being wasteful and unproductive of good results. He has been actively interested in the use of blast furnace gas, having been associated with Mr. Thwaite in this work. Mr. Booth is the author of books on liquid fuel, steam pipes, condensing plants, smoke, etc.

tool builders, who had to make new patterns anyhow, made them heavy, which suited the general views of tool making that had always prevailed, and which, from being a debatable fault, became a necessary virtue. Meantime the business boom in America increased and competition from abroad became less keen. The net result has been to establish the British tool maker on a firm basis, manufacturing tools that must be heavy before they are elaborate. Indeed, the new high-speed steels have eliminated much of the elaboration of the machine tool, and completely changed the general aspect of the business. When therefore we read, as we may sometimes do, that the import of American tools into Great Britain has declined from its high position of a few years back, we have to remember that the conditions were abnormal, that there was a time when any old second-hand tool would sell, perhaps, better than a new tool, and that the British industry was asleep.

There is, however, no reason to suppose that a steady business of exporting tools to Great Britain will not be maintained. Much depends on the attitude of the American tool maker himself. If he merely aims at selling surplus output, he will hardly expect to build up a steady export trade, for European buyers are shy of making purchases from sources which they suspect may suddenly become dry. This is, of course, only natural, for a man does not care to fill his shop with samples of all the makers of drill presses or planers. He wants a similar class of tool for all similar work. Just how far it may pay an American tool maker to foster his foreign trade must be entirely a matter for his own judgment. Many of them, no doubt, in bad times have felt glad to be able to ship surplus product to Europe at good prices, and while doing so have probably come to the commendable resolve to nurse foreign business. Then comes along a revival at their doors; the tool ready for shipment abroad is sold to a pressing home customer. The bird in hand is found to be more enticing than that still in the branches, and the foreign customer is put off, much to his distress, especially should he happen to have actually seen the machine intended for him in the last stage of work, for he then realizes that his interests have been sacrificed to those of another. But there seems no reason whatever why a steady business should not be done by the man who deals alike with all his customers. The probability is that by spreading his products over a wider field, he will find that his capacity of production is more evenly balanced with the average demand, for the coincidence of a maximum demand in a number of different countries is not probable. Rather will a peak in the demand in one coincide with a period of small demand in others, thus conducing to a more even general average.

Such, then, is a rough outline of the history and development of the British machine tool industry during a period of ten to fifteen years, which includes the great boom in the cycle trade, the revolution of British shop practise, and the invention of the high-speed tool steel which has removed to a further distance than ever the last syllable of the word "finality" as applied to the machine tool. The mere fact that high-speed steel will live and cut when red hot has entirely subverted all established ideas which were based on a conviction born of experience that a red heat in metals was incompatible with anything except a passive state. Once this deeply rooted idea has been destroyed, men's minds are prepared for further developments, and he would be a bold man who should attempt to lay any limit to physical and mechanical progress. The machine tool maker may therefore always live in expectation of some fresh turn of fortune's wheel which will bring a winning number opposite his shop door, whether it be on the east or west side of the Atlantic.

* * *

A trick worth knowing in case a crank-pin works loose or a press fit is made slightly too small is to heat the pin to a "black" heat and dip it into a pot of yellow brass, using boracic acid as a flux. Wipe off the superfluous metal as the pin is removed from the pot. In this manner a considerable thickness of brass can be evenly deposited on a pin, giving sufficient material for re-fitting the pin. In short, this is a "putting-on" process.

DEFLOCCULATED GRAPHITE AND THE "ACHESON EFFECT."*

Mr. Acheson, the discoverer of carborundum, has added another item to his list of important discoveries. This new amorphous substance, "deflocculated graphite" as he calls it, is described in the following abstract from an article in a contemporary:

In 1901 Mr. Acheson engaged in a series of experiments, having as their object the production of crucibles from artificial graphite. This led him to a study of clays, and he learned that American manufacturers of graphite crucibles import from Germany the clay used by them as a binder of the graphite entering into the crucibles; also that the German clays are more plastic and have a greater tensile strength than American clays of very similar chemical constitution; while residual clays—those found at or near the point at which the parent feldspathic rock was decomposed—are not in any sense as plastic or as strong as the same clays are when found as sedimentary clays at a distance from their place of origin. Chemical analysis failed to account for these decided differences.

Under these conditions, Mr. Acheson reasoned that the greater plasticity and tensile strength were developed during the period of transportation from the place of their formation to their final bed, thinking possibly it might be due to the presence of vegetable extractives in the waters which carried them. He made several experiments on clay with vegetable extracts, tannin being one of them, and found that a moderately plastic, weak clay, when treated with a dilute solution of gallotannic acid, or extract of straw, was increased in plasticity. Familiar with the record of how the Egyptians made the Children of Israel use straw in the making of bricks, and believing it was used not for any benefits derivable from the weak fibers, but for the extract, he calls clay so treated Egyptiarized clay.

In 1906 Mr. Acheson discovered a process of producing a fine, pure, unctuous graphite. He undertook to work out the details of its application as a lubricant. In the dry form, or mixed with grease or oil, it was easy to handle, but he wished it to enter the entire field of lubrication, as occupied by oil. In his efforts to suspend it in oil, he met the same troubles encountered by his predecessors in this line of work. It would quickly settle out of the oil. His unctuous graphite was just plain, simple graphite, and obeyed the same laws covering the natural product.

In the latter part of 1906 the thought occurred that tannin might have the same effect on graphite that it did on clay. He tried it with surprising results. The "effect," for such it must be termed, is produced with water and a comparatively small quantity of gallotannic acid, and when thus treated the unctuous graphite remains suspended in the water, showing not the slightest disposition to settle. The black liquid passes with ease through the finest filter paper. Severe tests have demonstrated that it is an admirable lubricant. There is every reason to believe that deflocculated graphite, with or without oil, will become a popular agent for all classes of lubrication, for, strange as it may seem, deflocculated graphite possesses the remarkable power of preventing rust or corrosion of iron or steel. The graphite appears to entirely neutralize the effect of the water in which it is suspended.

Mr. Acheson was desirous of mixing this graphite with oil, in order to meet the demands for a mixture of this kind. This was a matter of greater difficulty than was at first expected, but it has been finally accomplished, so that oil and graphite will run through fine filter paper, as described for a mixture with water. In these circumstances, Mr. Acheson now feels assured that he can meet any demand for a lubricant where oil is preferable, and evaporation of his water lubricant might be objectionable. It should be understood in this connection that the very lightest and thinnest of oils, when used in conjunction with deflocculated graphite, can be used in the place of the heavy and expensive lubricating oils of the present day, while the lasting qualities of these graphite lubricants will be greater by far than the oil lubricants which it is hoped they may displace.

*Orrin E. Dunlap, in *Scientific American*, May 11, 1907.

ADJUSTABLE REAMERS AND TAPS WITH INSERTED BLADES.

In the November, 1906, issue of MACHINERY a few designs of interchangeable body and guide counterbores were presented, and the reasons for making tools with the cutting members inserted were mentioned. The accompanying cut, Fig. 1, shows the construction of a reamer with inserted blades; the body and shank are made out of ordinary machine steel, while the blades and the binders are made of tool steel. There has been a number of various designs of inserted blade reamers on the market, but there are few which fill the requirements in all respects as well as the one presented here.

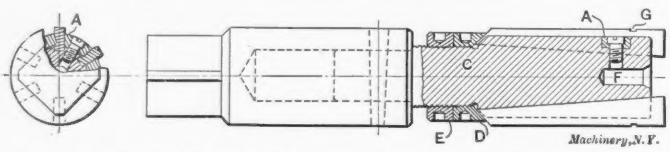

Fig. 1. Adjustable Hand Reamer with Inserted Blades.

As seen from Fig. 1, the reamer consists of a body *C*, which has one end turned down to fit into a hole in the shank, six blades, and six binders *A*, and finally a binding nut *D* and a check nut *E*, which are mounted on the threaded part of the body. The end of the body which is turned down to fit the hole in the shank is driven in place, and is secured by means of a taper pin. The body is slotted longitudinally to receive the blades, and has a circular groove all around to receive the binders. The latter are held firmly to the shoulder *B* on the blades (See Fig. 2) by means of screws which are threaded into the body. The hole *F* shown, extending in the center of the reamer a trifle beyond the center-lines of the binding screws, is for the purpose of providing clearance for the tap when tapping the screw holes. The blade is beveled off at an angle of 45 degrees at its upper end, and the binding nut is chamfered on the inside to correspond. This arrangement provides for a strong grip of the nut on the blades. The binders are made from a solid ring, being turned, chucked, reamed, and the screw holes drilled and counterbored, before the ring is cut into pieces. The blades are ground cylindrical for a certain distance towards the point of the reamer. This cylindrical part serves as a guide in starting the reamer. The remaining part of the blade, from the neck *G* upwards, is ground and relieved as an ordinary hand reamer.

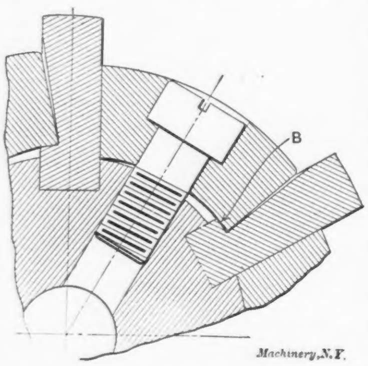

Fig. 2. Enlarged Section of Reamer, showing Method of Binding.

In Fig. 3 a shell reamer is shown of the same design. The hole is intended to receive a regular shell reamer arbor, and the reamer is driven by means of the keyway *H*. The blades of this reamer are shorter, are provided with a radius at the point like regular shell reamers, and are relieved all way up and slightly back tapered. This back taper is equal to 0.012 inch per foot. The radius *R* at the end of the blade should be about 1-16 inch for sizes up to 4 inches diameter and ⅛ inch for larger sizes.

The requirements for a good inserted blade reamer are that the blades, when bound in place, shall be practically solid with the body, that the design shall permit a liberal adjustment in regard to size, that this adjustment shall be easily accomplished, and that the means employed for binding and adjusting the blades shall not be of such a kind as to prevent the use of the reamer in any case where a solid reamer could have been used. The design shown in the cuts fills all these requirements. When the binders *A* are tightened down against the shoulder *B* in the blade, and the nuts are screwed tightly up against the end of the blade, there is very little chance for the blade to move. The tapered bottom of the slots in the body of the reamer, into which the blades are fitted, provide for the adjustment. When the reamer is worn, the binders are loosened, and the nuts at the upper end of the blades screwed back. The blades can then be moved upward as far as is necessary for recovering the original size, the nuts and the binders are again tightened, and the reamer may be ground to the exact diameter required. The ease of accomplishing this adjustment is apparent. No details either used for binding or adjustment project outside of the reamer, neither at the end nor at any place on the diameter of the body. The reamer can not only pass entirely through a hole, but it can ream down to the bottom of a hole, and even, to a certain width, face the bottom if necessary. Very few reamers of the ordinary adjustable or expansion type fill all the requirements so well.

This must not be construed to mean that this is the only adjustable reamer possible which will fill the requirements outlined. There can, of course, be a great deal of variation in the design, but the one in question, although patented in one important detail, is chosen as an example, because of embodying all the features which are of importance.

Inserted blade taps can also be made on the same principles. In a tap, however, it is not necessary, as in the case of a hand reamer, to have the shank nearly up to the full

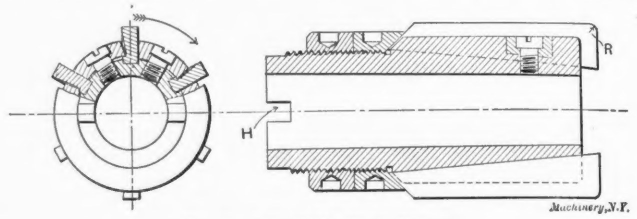

Fig. 3. Adjustable Shell Reamer.

diameter of the cutting tool itself. In the case of a tap, instead, it is required that the diameter of the shank shall be below the diameter at the root of the thread so as to permit the shank to freely enter the threaded hole. The tap can for this reason be made with the shank solid with the body. The only requirement for this is that the diameter of the shank must be below not only the root of the thread of the tap, but also the root of the thread of the threaded portion *K* (see Fig. 4). In small taps, however, this is not possible, as there the diameter of the shank would be altogether too small in comparison with the diameter of the tap. In such cases the same arrangement as resorted to in hand reamers must be adopted. Fig. 4 shows two taps, one with the body and the shank in a solid piece, and one with the body inserted in, and pinned to, the shank.

Another difference in the design which will be noticed is that the end of the blade, instead of being beveled, is made square with the outside face of the thread. This arrangement is necessary in order to insure that the different blades in the tap will have their teeth in such rotation that when the tap is used, a perfect thread will result. The adjusting nut is therefore made with a plain face instead of being beveled off

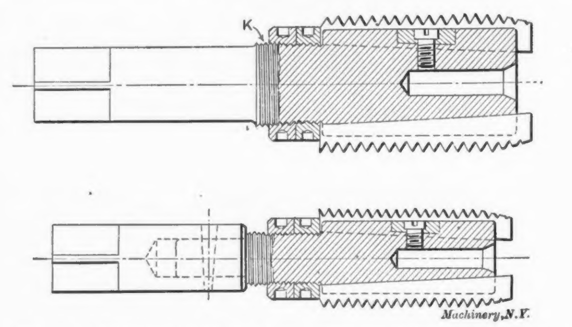

Fig. 4. Adjustable Taps made on same Principles as Reamers.

as in the case of reamers. It is evident that it is difficult to replace single blades, as they would hardly come in such a position as to produce a correct lead. For this reason it is customary to replace all the blades at once, preferably threading them right in the holder, or in a master holder similar to the tap. As there is no bevel on the adjusting nut to hold the blade down at the upper end, it is necessary to move the binding shoe in the case of the tap nearer toward the center of the blade.

NICKEL-CHROME STEEL.*

E. F. LAKE.†

E. F. LAKE.‡

Of the many high grades of steel which have been brought out in the past few years, nickel-chrome steel has, by both laboratory and practical tests, been placed in the front rank as the highest grade of steel manufactured, and it is used on all classes of high-grade machinery that require a steel of high tensile strength, high elastic limit, and a great resistance to shock and torsional stresses. It is one of the latest products of the steel maker. Only eight years ago this alloy of steel was comparatively very little known, and it was a boast of the Germans "that the entire steel trust of the United States could not duplicate a Mercedes front axle." In the last two or three years that boast, however, has ceased to be true. To-day this alloy is being produced by a number of American steel makers at a price much below the twenty-six cents a pound that the Krupp works gets for its highest grade of steel, in New York, duty paid.

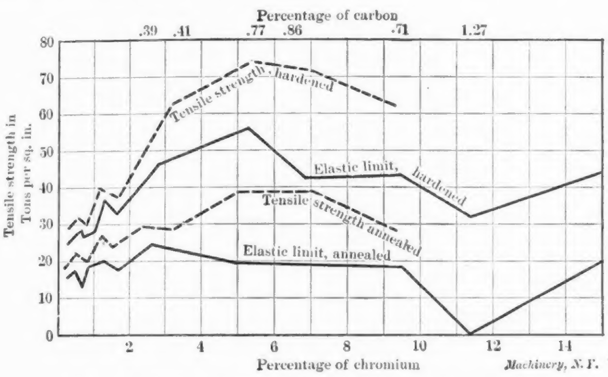

Fig. 1. Diagram showing Effect of Chromium on Steel.

Nickel-chrome steel is made in many different compositions, some of which are high in tensile strength, some in elastic limit, and others having different qualities, demanded for the different uses to which they are to be put.

The Effect of Chromium.

Chromium added to steel up to 5 per cent increases the tensile strength and resistance to shocks, and diminishes the elongation, while further additions lower the tensile strength. The elastic limit, in pieces not annealed, is raised at first, and afterward lowered. Chromium resembles carbon in its influence on the hardening qualities of steel. It refines the grain remarkably, owing to its tendency to prevent the development of the crystalline structure. Added to nickel steel, it overcomes the tendency of lamination, increases the elastic limit to figures that were impossible before it was brought into use, and when given proper heat treatment, the steel practically shows no grain or fiber, thus possessing a high power of resistance to shock. This alloy also strongly resists the propagation of cracks which may be produced by sudden strains. Chromium intensifies the sensitiveness of the steel to the quenching process, the resistance to fracture is higher than in carbon steel of the same degree of hardness, and for this reason extreme hardness may be obtained. Two per cent or more of chromium added to steel makes it very difficult to cut cold, although a special tool steel is made which overcomes this to a large degree. Chromium's action on steel becomes decisive above a content of one per cent.

The effect of chromium on steel is best illustrated by the diagram, Fig. 1, taken from Austen's "Introduction to Metallurgy." The lower dotted line shows the tensile strength of annealed pieces, the lower full line shows the elastic limit of annealed pieces, the upper dotted line shows the tensile strength of the steel, when hardened, and the upper full line shows the elastic limit of the steel, when hardened.

The Effect of Nickel.

The presence of this metal in steel is very interesting in its influence, as, when added to steel up to 8 per cent, it increases the tensile strength, elastic limit, and elongation. Adding from 8 to 15 per cent of nickel produces a brittleness, and the mechanical properties are not ascertainable by experiment. With 20 per cent nickel a rapid rise in extensibility is noticed, which increases very rapidly up to 25 per cent, after which the increase is more slow. Fig. 2 is a diagram from Roberts-Austen's "Metallurgy," which illustrates these points better than words will.

Nickel increases the ability of steel to withstand shock stresses even though the shape be intricate and lightened with holes. When properly combined with carbon, it largely removes the tendency of crystallization, and the steel may be hardened by the cementation process without fear of the core being brittle. If high in carbon, however, it will not stand local hardening, but may be oil tempered without difficulty. Nickel also gives steel a tendency to show laminations and makes it weak at right angles to the direction in which it is rolled. By the addition of chromium these laminations are removed, and the metal is given a high degree of homogeneity, the hardening can be performed more easily and without the danger of fissures appearing.

In nickel steel, the tenacity and elastic limit is much increased by positive quenching up to about 5 per cent nickel, especially with high percentages of carbon. Below 0.50 per cent carbon and 5 per cent nickel the reduction of area remains nearly unchanged, and the elongation but slightly decreases by heat treatment, but when chromium is added these are both reduced nearly one half by heat treatment.

Effect of Silicon.

Silicon is sometimes used in nickel-chrome steel, as it prevents the formation of blow holes and neutralizes the injurious tendencies of manganese. The majority of these steels, however, do not contain silicon, as its exact influence is not quite clear, and it is difficult to obtain silicon in steel without the presence of manganese. This makes its direct action difficult to determine. In quenching, silicon seems to influence steel the same as carbon in many ways, but this largely depends on the co-existing amount of the latter as well as of manganese. In general, only very small quantities are effective, and then only when the carbon content is low. Silicon will increase the tensile strength, but at the same time lower the elastic limit.

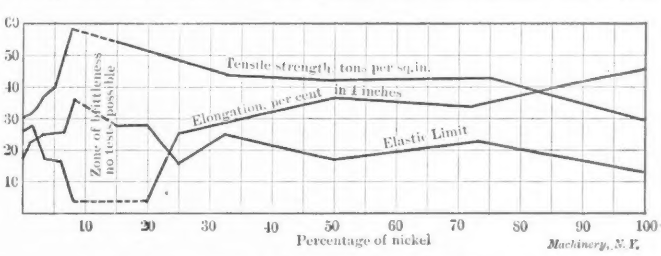

Fig. 2. Diagram showing the Effect of Nickel on Steel.

Effect of Manganese.

Manganese is always a component of nickel-chrome steel, but over 0.40 per cent is seldom allowed, as a steel high in manganese is difficult to work cold, while otherwise nickel-chrome steel can be bent cold without difficulty. This has been proved by tests which have been applied, one of which was a connecting or piston rod that, after finishing, was bent double and showed no indications of cracks. Another rod was twist-

*For additional information regarding the manufacture and characteristics of this and kindred steels, see the following notes and articles, previously published in MACHINERY: Remarkable Properties of Nickel Steel, February, 1903; Properties of Nickel Steel, March, 1903; The Effect of Vanadium on Steel, February, 1904; Krupp's Improved Spring Steel, February, 1904; Alloy Steels, August, 1904; all in engineering edition.

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‡E. F. Lake was born in Oswego, N. Y., 1863. He served an apprenticeship with the Straight Line Engine Co., Syracuse, N. Y., and has since been employed by The General Electric Co., Schenectady, N. Y.; Mesta Machine Co., West Homestead, Pa.; Lorain Steel Co., Lorain, Ohio, and The Garford Co., automobile manufacturers, Elyria, Ohio. Mr. Lake has a wide experience, having worked as machinist, molder, and pattern-maker, and has passed from the ranks to the positions of assistant foreman and foreman. For the past ten years he has made a special study of metallurgy and internal combustion engines, and has made many tests and experiments along these lines. He has contributed considerably to the technical press.

ed two complete revolutions without injury. When the carbon is less than 0.50 per cent, and from 4 to 6 per cent of manganese is added, steel becomes so brittle that it can be powdered under a hand hammer, but by the addition of twice that amount of manganese the strength is restored. At 15 per cent manganese, again, a decrease in toughness, but not in transverse strength, takes place. With 20 per cent and more of manganese a rapid decrease takes place. The discovery of these properties brought out manganese steel which has some remarkable qualities. The higher the percentage of carbon, the less manganese is necessary to bring about the result referred to.

Influence of Phosphorus and Sulphur.

Phosphorus and sulphur are always components of steel, and probably more time, more energy, and more money has been spent to get rid of these, or reduce them to a minimum, than on all other experiments. Phosphorus causes a "cold shortness" or brittleness in steel, and almost any quantity is injurious. No matter how high the tensile strength or elastic limit may be made by other components, if phosphorus is high, the metal will break when given shock tests. For this reason some object if phosphorus is present in amounts over 0.015 per cent, while others will allow as much as 0.04 per cent before they will agree that it is damaging to any serious extent. A high percentage of sulphur, on the other hand, causes a "hot shortness" or brittleness beyond a dull red heat, and is therefore not desirable when the metal is to be forged or worked hot. This component, however, is not as injurious as phosphorus.

used principally for gears, as these are the highest grades of steel in the market, either foreign or domestic, for this purpose. The nickel-chrome steels shown in the table that contain 0.25 per cent carbon are more extensively used than those with higher carbon content, as they are forged easier, and are machined and worked with less difficulty. These steels are used where great strength is demanded, combined with a light weight; hence, in automobile construction they are used for such parts as crank shafts, sprocket shafts, rear driving shafts, propeller shafts, axles, wheel pivots, and piston rods. Some racing cars have been built with all the working parts, as well as the frame, of nickel-chrome steel.

These nickel-chrome steels are not as readily drop-forged as the ordinary carbon steel, and therefore the difference between consecutive die forms should be less than in those used for ordinary steel. In forging, the metal should be heated to about 1,380 degrees F., and kept at about that point until the operation is completed. Care must also be taken not to overheat or underwork the metal, as this produces a coarse grain, which will show a low percentage of reduction of area, and the metal will be condemned on account of its inability to withstand the shock stresses. The best forging process is undoubtedly the one using the hydraulic press, as with this the metal is slowly squeezed into the die, thus allowing the mass time to assume its new shape. The formation of crystals will not be able to take place, and the metal will be of a finer grain, with greater density, producing less internal stresses and closing up any flaws which might have been in the center of the ingot. In hammer forging, unless the hammer is a large, slow-moving one, only the shell of the forged piece is affected, as the blows will not penetrate to the center.

TABLE SHOWING DIFFERENT COMPOSITIONS OF NICKEL-CHROME STEEL AND THEIR STRENGTHS.

Nickel, per cent	1.60	3.30	4.40	3.50	2.09	3.38	1.50	1.50
Chromium, per cent	4.41	1.40	1.50	1.50	0.71	1.87	0.80	0.80
Carbon, per cent	0.25	0.31	0.25	0.25	0.36	0.24	0.25	0.45
Silicon, per cent	0.20	0.20	0.24	0.25	0.21	......	......	......
Manganese, per cent	0.35	0.40	0.73	0.40	0.35	0.35	0.40	0.40
Phosphorus, per cent	0.012	0.012	0.013	0.018	0.025	0.028	0.03	0.03
Sulphur, per cent	0.013	0.028	0.012	0.022	0.026	0.03	0.035	0.035
Fully Annealed.								
Tensile Strength, pounds per square inch	126,000	115,000	......	126,000	112,000	123,000	85,000	90,000
Elastic Limit, pounds per square inch	115,000	95,000	......	115,000	87,000	80,000	65,000	65,000
Elongation in 2 inches, per cent	28	24	......	28	14	10	20	18
Reduction of Area, per cent	64	42	......	64	64	53	50	35
After Heat Treatment.								
Tensile Strength, pounds per square inch	185,000	155,000	154,000	......	......	......	130,000	180,000
Elastic Limit, pounds per square inch	160,000	132,000	133,000	......	......	......	100,000	140,000
Elongation in 2 inches, per cent	14	38	12	......	......	......	12	8
Reduction of Area, per cent	48	16	25	......	......	......	30	20

Composition of Nickel-chrome Steels.

The different combinations or percentages of the components of nickel-chrome steels are as varied as their makers, but the compositions obtained have resulted in a very high grade of steel. Thus nickel is used in percentages of from 1 to 5, chromium from ½ to 5, carbon from 0.25 to 0.45, silicon, when used, from ½ to 3, and manganese from ¼ to 1. The table above shows some of the nickel-chrome steels that are turned out by the different makers, both foreign and American, and their comparative strength. The first column shows one composition that is comparatively low in nickel and high in chromium, while the next three columns are low in chromium and high in nickel, other components being about equal. The last two columns contain the specifications adopted by the Association of Licensed Automobile Manufacturers. The only difference between them is that one contains 0.45 per cent carbon and the other is 0.25 per cent. The physical characteristics of these two kinds are not derived from actual tests, but are the characteristics which they must possess when a test is made from a ⅞-inch test bar, rolled from every heat and from two separate ingots. The actual test may show much higher figures, as these are the lowest figures at which the steel will be accepted. The phosphorus and sulphur may, of course, be lower, as the percentage given is the highest that will be allowed. To the tests in this table there should be added a shock test, as all of these might be satisfactory in their results, and yet, if too high in phosphorus, the metal would not stand shock and torsional stresses.

The steels given in the table which are high in carbon are

Heat Treatment.

This steel is nearly always heat treated, and great care should be used in doing this, as it is very easy to destroy the good qualities of the metal by inferior workmanship in this regard. The factors which influence the results of heat treatment are:

First: The physical and chemical components of the metal.

Second: The gases and other substances which come in contact with the metal while heating.

Third: The form of the temperature rise curve for each unit of the metal.

Fourth: The highest temperature given to each unit of the metal.

Fifth: The length of time at which the metal is kept at the maximum temperature.

Sixth: The form of the temperature drop curve for each unit of metal.

At about 570 degrees F. most steels lose their ductility and are not capable of resisting the strains of unevenly heated metal. Therefore, the temperature rise curve up to this point should be a gradual one; after this it may be as rapid as possible without overheating. Care must be taken not to overheat or burn the metal, as it is almost impossible to bring it back to its former high standard.

Nickel-chrome steel should be annealed after it has been worked and before heat treatment, in order that it may return to its natural state of repose, as machining, forging, hammering, etc., is liable to throw it out of its homogeneity. It is

annealed in a different manner from the ordinary grades of steel, it being heated to a temperature of about 1,470 degrees F., kept at this heat for four hours and then allowed to cool slowly in a slow-cooling furnace, or by packing in ashes or charcoal, the latter being preferred. If carbonizing is resorted to, this steel should be annealed, after carbonizing, as described above.

To harden this steel, it should be heated to about 1,470 degrees F. and made as hard as possible by quenching in oil or water, after which it can be drawn to the different degrees required. Gears should be drawn by heating to 480 degrees F. to remove the internal strains. This makes the hardest and toughest gear which it is possible to make. It will stand an enormous amount of wear and shock stresses, and it is very difficult to break out a tooth with a sledge hammer.

The carbonizing should be done by carefully packing the pieces to be carbonized in a cast iron pot, in a mixture of powdered bone and charcoal. This should then be heated slowly until the temperature is raised to 660 degrees F., after which the temperature can be raised as fast as desired until 2,100 degrees F. has been reached. The steel should be kept at this temperature for at least four hours, after which it should be allowed to cool slowly by taking the pot out of the fire and permitting it to cool without removing the cover. This annealing, tempering, and carbonizing can only be done successfully and with positive assurance by the use of a furnace to which is attached a pyrometer, as the proper degrees of heat cannot be guessed at by the color of the metal.

Machining Nickel-chrome Steel.

Nickel-chrome steel is more difficult to machine than ordinary steel. This can only be done successfully when fully annealed and with high-speed tool steel. Under these conditions it should be cut at the rate of 35 feet per minute, the cut being 3/16 inch deep, with 1/16-inch feed. The comparison between the machining of this and other steels is best illustrated by the following table:

TABLE SHOWING CUTTING SPEED FOR DIFFERENT GRADES OF STEEL.

Depth of cut $\frac{3}{16}$ inch and feed $\frac{1}{16}$ inch.

Kind of Steel.	Cutting Speed in Feet per Minute.	Pounds of Turnings per Hour.
Steel with 0.10 per cent of carbon	100	295
" " 0.20 " " " "	75	222
" " 0.30 " " " "	63	176
" " 0.40 " " " "	51	150
" " 3.50 " " " nickel	55	163
0.75 per cent nickel, 0.80 per cent chromium, and 0.25 per cent carbon	50	148
1.50 per cent nickel, 0.80 per cent chromium, and 0.25 per cent carbon	45½	135
Steel with 1.5 per cent nickel, 0.80 per cent chromium, and 0.45 per cent carbon	35	103

This steel is only used where strength and lightness are more important than cost. In automobile construction, it is only used on the higher priced cars and for the parts which have to stand the largest amount of strains and stresses. Its ability to stand these stresses better than the ordinary carbon steel was demonstrated by one motor car builder, by taking two round bars 1¼ inch in diameter, one of which was nickel-chrome steel and the other a mild carbon steel, fairly low in carbon, gripping both ends, leaving 9½ inches exposed and subjecting them to a bending operation, the bending being 9/32 inch out of the true position of the center-line of the bars. This bending was made, back and forth, with the carbon steel bar 20,000 times before it fractured, while with the nickel-chrome steel bar 250,000 bendings were made before this fractured. Other tests, which have been made by the writer, show similar results.

With the continued use of this grade of steel, its manufacture in larger quantities by the steel makers, and the improvements in machinery and cutting steels, it will no doubt be cheapened both in the production and in its manufacture into finished products, so that its use can become more diversified, and better wearing qualities, lighter weight and greater strength given to the working parts of many classes of machinery.

METHOD OF HARDENING THIN MILLING CUTTERS.

J. F. SALLOWS.*

Based upon my experience of years in hardening and tempering all kinds of tools, it is my opinion that where there is a quantity of thin milling cutters to be hardened and tempered, they should be arranged on a mandrel, as shown in Fig. 1. This view shows ten milling cutters varying in size from 3 to 4½ inches diameter, all having ½ inch cutting face. They are all arranged on one stud or mandrel, with a washer on each end of such diameter that it allows the cutters to harden to sufficient depth to provide for numerous grindings, and at the same time not harden to such depth as to cause warping or

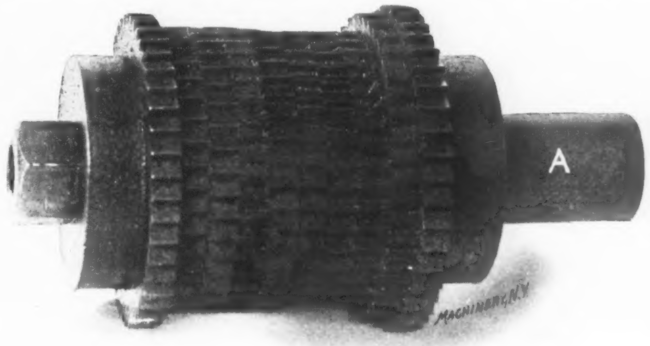

Fig. 1. Thin Milling Cutters Mounted on Arbor for Hardening.

cracking. Cutters 1/16 inch thick and upward should be hardened in this manner, as the method does away with any possible warping, and it insures uniform hardness.

Fig. 2 shows the stud, washers and nut before the cutters are put on the stud for packing. The stud should be of such length at the large end *A* as to permit of a good tong hold. A washer is put on first, and then the cutters are put on, followed by the other washer. The nut is tightened as tightly as possible, and the cutters are then packed in a pipe large enough to allow ½-inch clearance between the teeth and the inside of the pipe. They are packed in fine wood charcoal, and the ends of the pipe are sealed with asbestos cement. Heat in a furnace, or if no furnace is at hand, place the pipe over an open fire on a large forge and cover with coal or hard coke. If the pipe does not heat uniformly, roll it over and over. This is an advantage of a pipe over a box for pack-hardening, it being readily turned so as to heat the contents uniformly.

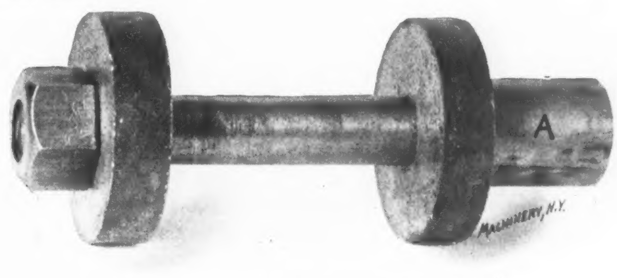

Fig. 2. Arbor used when Hardening Thin Cutters.

The cutters shown in Fig. 1 were dipped at a bright red heat in cold salt water, and while still quite warm were removed to a tank of fish-oil to draw down. They came out straight and were hard from outside cutting edge to within about ⅛ inch above the washer line. This method, in my opinion, is the best way to secure a first-class job of this class of tools when hardened in quantities.

* * *

Some metals will amalgamate when in contact, even when at ordinary temperatures. Gold in contact with lead will permeate the lead for a considerable distance from the point of contact, and it is said that if a zinc disk and a copper disk are held together for a number of months under pressure, that the surface of the copper will be found covered with a film of yellow brass.

*Reo Motor Car Co., Lansing, Mich.

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PURE DRINKING WATER IN SHOPS.

It is a matter of great importance in shops, mills and factories that the water supply for employes be not only potable, but safe. It is also desirable that the water system be so distributed that men can get a drink without walking long distances. The torture of thirst in hot summer days is unendurable, and men must drink though they incur the displeasure of their foremen by leaving their work and going to the water supply. If the water supply is convenient many steps will be saved; but of the greatest importance is the matter of providing a safe water supply. By this we do not mean, necessarily, water which does not produce actual sickness, like typhoid fever and other dangerous diseases, but water that is also free from contaminating germs that produce lassitude, general debility and a condition of poor health, without actual sickness. No doubt, there are manufacturing concerns having water supply of doubtful purity that would find the installation of an efficient filtering and sterilizing system an investment netting big returns. The president of one large company, having had experience in this feature of works management, speaks enthusiastically of the improved condition resulting from a first-class water supply. He says that since a system of water purification was installed, the average number of idle machines in the shop has been reduced from fourteen to two, and he estimates that it has more than paid for itself each of the three years it has been in use. This is rational shop welfare work that appeals to employers and employes, for it saves both the health and pocketbook, and promotes general efficiency.

* * *

THE SCARCITY OF SKILLED LABOR.

During the last year there have been occasional complaints about the scarcity of labor, and it appears that this scarcity is particularly noticeable in industries requiring very highly skilled men, well trained in their trade, and also in industries requiring very cheap labor. There does not seem, as yet, to be any scarcity of workers in such industries where comparatively good wages are paid for labor not very highly skilled. The scarcity of men, in the two groups referred to in the first place, must depend upon two entirely different causes. In the latter group, consisting of cheap help, men are scarce, because our present prosperity has made it possible for a number of men formerly employed at cheap wages to find employment in more lucrative positions, and this scarcity of help is only temporary, and will not continue when the high tide of industrial activity commences to recede. In the former group, that of highly skilled workingmen, the cause is a different one and one which, from an industrial point of view, is of far greater importance. Our industrial system does not produce the same number of skilled workmen in proportion to the demand as it did twenty or twenty-five years ago. For this reason the present scarcity of men of this class may prove permanent for many years to come, and the only remedy in sight is to find some way by which to educate a certain number of young men in certain trades, so as to attain the necessary skill, and fill the vacancies which are brought about by the dropping out of many who were initiated in their trade a generation ago. In the shops to-day, as everybody well knows, the boy or young man who expects to learn a trade is too often put to work in a special department where his range of knowledge and general ability is becoming very limited. Under such circumstances, there is no wonder that manufacturers commence to realize that there are no men available to fill the places of the good all-around mechanics which one by one pass away. With our industrial activities permanently increasing, and the chances for a young man to thoroughly learn a trade decreasing, it must come to a point where necessity will demand the inauguration of some organized effort of educating young men in the trades, either inside or outside of the productive industrial establishment. For this reason the steps taken by the National Machine Tool Builders' Association in order to investigate the subject of apprenticeship systems, and, if possible, bring about the adoption of a fairly uniform system throughout the country, are to be highly commended, as well as the effort made for establishing trade schools outside of the factories. Both tendencies point toward increased realization of the necessity of systematically educating the coming generation for the work to be performed.

* * *

PLAN OF THE SHOP OPERATION SHEETS.

The methods shown in the shop operation sheets, now forming a feature of all editions of MACHINERY, are not the only ones that can be used, nor are they necessarily *the* ones that should be preferred to obtain the best results. On the contrary, we recognize that there may be several other methods of doing an operation equally as good, or some, perhaps, in certain cases even better, than the one chosen for the illustration. The selection of a method to illustrate will be determined by these factors: first, simplicity; second, the avoidance of special tools; third, the enunciation of sound mechanical principles that may be employed in general practise. In most cases, we shall confine these shop operations, in the case of machine operations, to standard machine tools, and shall avoid the use of special tools or appliances, for the present, save where absolutely necessary. Where precise measurements are required, it will be supposed that the ordinary micrometer is available, but ordinarily the usual tools employed by the machinist should suffice. Exceptions will occur, as, for example, in the case of gear cutting, where there seems to be no escape from the use of the vernier gear tooth caliper or special fixed gages for determining the exact thickness of tooth on the pitch line.

It perhaps will be the case in some operation that a much simpler method may be used than the one we show for an example, as for instance, centering a gear-cutter, as was illustrated in the May issue. It has been suggested by a correspondent that the use of a sharp-pointed center in the dividing-head is very common and is regarded as good practise when carefully done, but centering cutters in this manner is something that can be done only with a gear-cutter or other cutter that has the center line marked thereon. The method shown in the operation sheet referred to is equally applicable to all kinds of symmetrical cutters, and in showing it a principle was explained that is of much practical value in general milling machine practice. The limits of space of this operation sheet would not permit the description of the alternative practise also, and in choosing between any two practises, we believe it best to show the one that means the most to the mechanic, and to assume that the short cuts are safest when the basic principles are known as well.

WRITING LETTERS IN A BUSINESS-LIKE MANNER.

It is very common among a certain class of office people to hear criticisms pronounced on explicit letters because of not being written in a "business-like way," the business-like letter evidently being supposed to be one that is short and meager in its wording. This, however, must be considered an erroneous opinion, and is daily causing a great deal of extra work and trouble in business life. The ideal business letter is one which in as short a space as possible clearly transfers the thoughts of the writer to the reader. To do this in very few words is often impossible, and while some men may have a great ability of expressing themselves at the same time clearly and concisely, the majority of letter writers need about as many words to convey their ideas as they feel inclined to use. For this reason it is a mistaken policy to sacrifice clearness of expression to the notion that business letters should necessarily be short. They should be as short as consistent with perfectly clear and definite statements, but not a word shorter, no matter how many pages are necessary for the writer to express his ideas.

It is said that the man at the head of one of our largest machinery firms never reads a letter which extends over more than one sheet of paper. The opinions of such a man necessarily have great weight with his subordinates, and they will eagerly try to make a rule of not writing any longer letters. This gentleman himself may possess a special ability of clear thought and of short expression, but the majority of the clerks and employes of the company lack such an ability and conform to such arbitrary rules only by failing to make their letters convey their ideas. The writer, when in the employ of a large manufacturing concern, had often occasion to make inquiries in regard to certain orders given by customers who could be reached only by writing. A draft of the letter was made, stating the case and asking, as clearly as possible, for the information wanted. In certain cases where the subject in question was complicated it was impossible to confine the matter to a very limited space. This draft was passed in to the business office where the matter was "boiled down," as the expression was, to conform to the rules of business-like letters, and the result often was that two or three letters had to pass between the firm and the customer before plain understanding could be had. This, of course, could all be blamed to the inquirer's way of asking his questions, and not to the "boiling down" process to which the questions had been subjected, had it not been for the fact that in a few cases where the writer's drafts were strictly copied, the information asked for came as expected. All of which is intended to prove that the "business-like" letter, so-called, has its drawbacks.

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GENIUS UNDER CONTRACT.

CHARLES CLOUKEY.*

Some of the most progressive and far-seeing manufacturing and engineering concerns have adopted various forms of profit-sharing policies with the end in view of increasing the interest and efficiency of their working forces. The move is a very commendable one, and, so far as is known, is a successful one, and contrasts very strongly with the contract system of some of the largest and most influential corporations in the United States, in which they bind the employes to give the company all the benefits of their inventive genius.

A published statement not long ago asserted that many concerns maintained a very large corps of inventors, sometimes several hundred or a thousand for a single firm, and these men were employed to invent improvements and appliances in the line of manufacture in which the company was engaged. The facts in the case point to the contract system used by the great Westinghouse interests and many others, in which the applicant for any position signs a contract to assign any and all inventions he may accomplish while in the employment of the company.

There are at least two pernicious features to such a method, the first one being the well-known fact that many capable men find themselves in such stress of circumstances as to make it imperative for them to secure employment, although it involves a mortgage upon their genius; and the second is a tendency to indifference in the matter of invention where there is neither credit nor profit coming to the inventor. Of course, there is occasionally a man who will do his best and spend much of his own time just for the sake of accomplishing something in the world besides his stint of daily toil; but in the great majority of cases there will be an indifference or an effort to evade the contract. Most inventors who have had no experience do not realize the difficulties which lie between themselves and fortune after their patent is a matter of possession, and so they will quit the service or take out the patent in the name of a friend, and then find that the company that would have utilized it in the first case is entirely indifferent to its merits in the second.

So I say, that for several good reasons, the unqualified contract system of the control of inventions is pernicious in its general effect on progress, and does not give the results expected by the party of the first part.

In strong contrast to the foregoing is the system adopted by more progressive and considerate business concerns who ask their employes for ideas on improvements in machinery, appliances and methods, and whenever one of these suggestions is adopted, the author of it is rewarded with a definite sum, due him above the regular wage which he has earned by the performance of his usual duties. These rewards are not of uniform value, but are based upon the relative augmentation of profits following the adoption of the improvement, and in many cases amount to much more than the inventor could have realized had he patented the contrivance and trusted to a sale of the patent. Another commendable feature of this plan is that many ideas of value which are not patentable bring a substantial reward to the workman without extra investment or delay, and perhaps as great profit comes to the firm in the end from the general good feeling aroused in the skilled workman and the common laborer alike, for there is such a vast difference between a man's best service and his grudging toil, that at the same rate of wage one house will go on to prosperity and another will go into bankruptcy.

However, there is one commendable feature common to both of the systems referred to, and that is the encouragement and opportunity for the development of new ideas from the standpoint of physical means. All the machinery and appliances of the firm are at the inventor's service if the invention promises anything worth while, and this is enough to encourage many a man who has an inventive turn, even though he gets nothing extra out of it. But it is a good business principle that holds in mind as well as in merchandise, that whatever is worth using is worth paying for, and many an inspiration has died, reflecting upon this axiom.

The relative value of the two methods will in time become apparent even to the great corporations, and they will adopt that which will pay them best, and as is true in nearly every case, what will pay the employe the best will pay the employer best, and the rule works both ways when there is good feeling and mutual interest between the principals in the labor problem.

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A contributor to the *Saturday Evening Post* writes of "millions in old iron," and paints a truly wonderful picture of what is going to happen in the next few years in scrapping existing machinery because of industrial progress. For example, the article states that the scrap iron business leads all other lines of metal trade and is being greatly stimulated by the substitution of electricity for steam by so many railroads of the country. It is estimated (by whom?) that within the next five years 30,000 steam locomotives will go to the junk heap, etc. The steam locomotive has been consigned to the junk heap by several writers and would-be prophets, but this is the first time that we have seen a definite period given for the wholesale consignment of over half the total number in the country. We believe the writer has "another think" coming. If we are not greatly mistaken, there will be more steam locomotives in use in 1912 by many thousands than there are at this date, notwithstanding the growth of electric traction.

ENGINEERING REVIEW.

CURRENT MECHANICAL EVENTS—LEADING ARTICLES OF THE TECHNICAL PRESS.

New York's new child-labor law provides that no minor under sixteen years of age shall be employed or permitted to work in any factory in the state before 8 A. M. or after 5 P. M. The new law goes into effect January 1, 1908.

In all countries where an abundant supply of water power is available, the question of the electrification of railways is at the front. In Switzerland a report, prepared by experts, is now at hand, which is in favor of the general adoption of electric traction throughout the country.

Steps have been taken to construct, at San Francisco, the largest dry-dock in the world. This dock will be 1,050 feet long, and is to be constructed at the estimated cost of $1,250,000. It will be large enough to hold at once any two ordinary large-sized ocean steamers, the late giants, however, excepted.

It is mentioned in *Engineering* that the longest distance over which the human voice has been transmitted is believed to be from Montreal to Winnipeg, 1,430 miles, over a special copper wire along the Canadian Pacific Railway. This wire was installed by the railway company for its telegraphone system, by means of which two messages—one by telephone and the other by telegraph—can be transmitted simultaneously over the wire.

An interesting novelty that has been on the market for a few years is a magnetic incandescent lamp holder, chiefly intended for use in machine shops. The holder is made with a base which is magnetized when the lamp is burning. The magnetized base holds the lamp firmly to any iron portion of a lathe, planer, drill or other machine tool so that the light may be held and directed exactly where required. The convenience and novelty of the device, together with its simplicity, makes the beholder who first sees it wonder why the idea was not thought of long ago.

The gun trade of Birmingham, England, which city was for a long time the most important center for this industry in the world, has of late years declined, while at the same time the gun-making factories of Liége, Belgium, have greatly increased. It is stated in *L'Echo de L'Industrie* that, while the number of gunsmiths in Birmingham in 1860 was 16,840, there are now only about 4,000, while at the present time the number of gunsmiths in Liége is 40,000. About thirty years ago England possessed more than half of the gun trade of the world. Now Belgium has acquired 65 per cent of that trade, and is able to reckon England among her best customers.

In a report regarding the government railroads of Germany, Consul-General Richard Guenther says that the Prussian State railroads, after payment of the interest of the debt, showed an excess of earnings over expenditures in 1905 of $119,830,000, and in 1906, $134,520,000. A showing like this, amounting to a net profit of from 6 to 6.65 per cent of the actual capital expended, after the payment of interest, well indicates the possibilities of government ownership of railroads, and when the low passenger rates, the comparatively low freight rates, and the high standard of service of German railroads is considered, the financial results are the more surprising.

Recognizing the need of a business education, as well as a technical training, for engineers, a course in business practise has been instituted at the technical institute at Danzig, Germany. It has always been the practise in European technical schools to give a limited instruction in bookkeeping and ordinary business practise, but the course in question is to be more complete in its scope. It is beyond doubt that this move will prove of great value, and it would be highly commendable if higher technical institutions in this country adopted this idea. The technical graduates from our foremost technical colleges are almost certain to sooner or later be placed in a position where a business education, specially adopted for the man of technical training, would be of great value.

It is reported by *The Engineer*, Chicago, that tests recently made by Prof. H. B. MacFarland, of Armour Institute, on a concrete girder, 18 x 18 inches, with five 1¼-inch iron rods bedded in the bottom, showed that, when exposed to heat, the girder began to deflect at a temperature of 640 degrees F. This deflection continued throughout the test, reaching 5 inches in three hours, the temperature being somewhat less than 2,000 degrees when at its maximum. The length of the girder between supports was 16 feet 6 inches. Loads were applied at 6 feet 1¾ inch from each end by means of jack screws seated against car springs bearing on brick piers, 2.5 tons being applied at each loading point. After the fire was extinguished, the deflection continued with the load decreasing until the deflection was 8 3/16 inches and the load 0.75 ton.

In our November, 1906, issue we mentioned the installation of an electric steel melting furnace in the works of Henry Disston & Sons, at Tacony, near Philadelphia, Pa. The success with this furnace has been so great that the company is now considering the installation of a much larger electric furnace plant. The furnace which is at present in operation was manufactured by the Induction Furnace Company of America, Philadelphia, under patents of Mr. Edward A. Colby. Henry Disston & Sons have been the pioneers in the introduction of the electric induction furnace practise for the manufacture of high-grade crucible steel. In Europe as well, the continuous induction furnace for electric smelting is making great strides. The latest construction is one brought out by Mr. Albert Hiort, a Norwegian engineer. This furnace applies the same principles as the others of its class, and its novelty is to be found merely in its design.

One of the most radical departures in the way of taking care of a country's natural resources, but at the same time one of the most hopeful signs of our commercial era, is that of the Swedish government having adopted a plan of taking over the immense iron ore deposits in the northern part of that country. The private company, which is at the present time working the mines, will have the right of exploitation for 25 years to come, but will meanwhile be permitted only to mine a certain definite amount of ore. After that time the ore lands will be transferred to the State. The aggregate amount of ore in these ore lands is estimated at from 500,000,000 to 800,000,000 tons. In view of the fact that natural deposits of this kind are plainly the property of the nation as a whole, and cannot consistently be left to enriching private individuals, in no way responsible for the existence of these deposits, it is gratifying to hear that some statesmen are recognizing the necessity of asserting the right of the people to the bounties of nature, at the same time as the prevention of a monopoly assures of a greater impetus to competitive industrial development.

The present high standard of shipbuilding, as far as safety is concerned, has perhaps never been more plainly demonstrated than in the case of the salvage of the White Star liner *Suevic*, which some time ago ran full speed upon a submerged rock outside of the Scilly Islands. It was found impossible to take the ship, which registered 12,500 tons, off the rock. It was therefore decided to leave the fore part of the ship, which was fast on the rock, where it was, and sever it from the after portion which contained the most valuable parts of the ship, her engines, boilers, etc., and by so doing save this part. A continuous line of dynamite cartridges were carried around the vessel, electric connection made to a distant point, and the cartridges exploded. The action of the dynamite cut the steamer in two, and two-thirds of the vessel floated away intact, this being made possible by the several

water-tight sections with which all modern steamers are built. The *Suevic* was taken to Southampton for repairs, presumably for being provided with a new bow instead of the one she left on the rocks of the Scilly Islands.

Users of gas engines on a large scale are commencing to realize that the heat carried away by the exhaust from gas engines amounts to about one-third of the total heat generated, and that the exhaust gases, being at a temperature of about 1,000 degrees F., are capable of raising a large amount of steam, provided that a boiler suitable for the purpose is installed. According to the *Railway and Engineering Review* such boilers are now being placed on the market. They should be placed as near to the engine cylinder as possible, and they consequently form a perfect exhaust silencer. When the gases have passed through the boiler they escape into the atmosphere by a pipe which is free from the usual nuisance of heat and noise. Inasmuch as gas power has not so far been favorably considered in many plants because of the need of the exhaust steam from steam engines for special purposes, there is now a chance for the adoption of the exhaust gas boiler to raise steam for heat or other purposes, while the motive power is gas, and thus a double measure of economy and usefulness is attained. In one factory in England these boilers are generating steam from the heat of the gas engine exhaust gases equivalent to the steam generated by 70 tons of coal per week.

After having undertaken experimental electrification of short railway lines, the Swedish government seems to be intending to put electricity to use on the Swedish State railways on a scale not having yet been attempted elsewhere. In *Teknisk Tidskrift*, of May 4, we find a complete plan for the electrification of the State railway system in the southern part of the country, comprising a length of lines of about 1,300 miles, the electric power for which would be supplied from five power stations, all, for the generation of power, making use of some of the numerous water falls of the country. The financial possibilities have been considered, and it is stated from good authority that the electrical working of the State railways would offer a saving in operating expenses. At the same time a better and more convenient passenger service could be installed. In Germany, the electrification of a line from Hamburg to Kiel, about sixty miles long, is under consideration, this line being intended to be an experimental one, on which estimates for electrification on a larger scale could be based. Norway is also planning for using the power of its water falls for the generation of power for its State railways, and a small portion of these railroads is to be electrified for experimental purposes there as well. These projects for electrification do not only include electric power for passenger service, but the freight service is to be placed on the same basis also.

The following is the color scheme adopted in the power plant of the Pennsylvania, New York & Long Island Railroad Co. in Long Island City, N. Y., which was devised by Westinghouse, Church, Kerr & Co.:

White—High-pressure steam lines.

Bright red—Drips from superheated steam lines, including the Holly system and connection to boilers.

Bright red with black flanges—Saturated steam lines and Holly system connection.

Yellow—Exhaust from auxiliary apparatus and low-pressure drip lines.

Black—Boiler feed piping from boiler feed-pumps to boiler drums, including heaters, economizers, and their connections.

Blue—All water piping, except the boiler feed lines and fire lines.

Structural color—Fire protection system; painted to match the structural steel to which it was adjacent.

Maroon—Blow-off piping.

Green—Air lines.

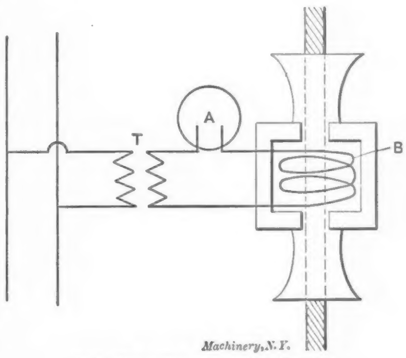
Slate—Crank-case oil piping between engines and separators.

Brass—Unpainted, all oil lines except those painted slate color.—*Engineer.*

APPARATUS FOR DETECTING WEAR IN WIRE ROPES.

C. McMann, before the Transvaal Institute of Mechanical Engineers.

An apparatus for detecting variation in the cross sectional area or wear in wire ropes was described recently at a meeting of the Transvaal Institute. The illustration shows the scheme of the apparatus. An alternating current passes through a transformer *T*. The secondary of the transformer is connected to a coil *B*, through which the wire rope to be tested is threaded. This coil *B* may be designed to open up, enabling it to be applied to a rope without the trouble of threading the rope through it. At each end of the coil proper are bell mouths, which are to guide the rope into the coil. The coil is also enclosed in a laminated iron cylinder to concentrate the magnetic field within it. An ammeter *A* is inserted in the secondary circuit. When there is no rope inside the coil *B*, the self induction is low, and the current consequently is large. On introducing the rope, the induction is increased and the current falls exactly in proportion to the size of the rope so introduced. In practical use, the rope is threaded through the coil *B*, and slowly passed through it, the person in charge of the test watching the ammeter, the reading varying in direct proportion to any decrease in cross sectional area of the portion of the rope at that moment in the coil. Thus the exact amount of wear on the rope can be determined direct from the ammeter readings. If so desired, the ammeter may be of the recording form, thus obviating the necessity of an observer watching it during the time of the test.



Detecting Wear in Wire Ropes.

PROPER PACKING.

Daily Consular and Trade Reports, March 14, 1907.

Mr. Paul Roux, a member of the American Chamber of Commerce in Paris, calls attention to the necessary requirements for proper packing for trans-Atlantic shipments. Particular stress is laid on the following points. The machines should be more or less completely dismantled before packing; attention must be given to the resistance of the tool and its various parts to rough handling in transportation. It must be remembered that a packing case must protect the machine not only against pressure and blows which it may receive in a normal position, but also protect the machine against abnormal stresses resulting from overhanging position or overturning. No part of the machine should be in contact with the sides of the case unless the sides are made strong enough to withstand the pressure, should the full weight of the machine be thrown upon them. Feet of lathes, beds, and similar parts are frequently broken by the packing case falling even lightly on one of its corners, even when the case itself shows no external evidence of a fall. An important consideration in packing a machine for trans-Atlantic shipment is its volume when packed. Marine freights are generally figured at so much per ton weight, or per 40 cubic feet volume, at the option of the carrier. The exporter has, therefore, an interest in seeing that the weight, which, of course, remains constant, does not occupy a space greater than 40 cubic feet per ton. Nearly all machines, however, if not dismantled and compactly packed, make up into packages greatly exceeding 40 cubic feet per ton. When dismantling, on the other hand, it must be remembered that parts requiring accurate adjustment, and which are difficult to assemble, should be left intact, and the exporter must use his best judgment in such respects.

In designing the packing case, it is very necessary to make provision for the examination of the machines in a foreign custom house. An opening should be provided on the side of the case, or in the cover, through which the nature of the

machine may be readily seen. This opening must be large enough to permit the examination of all parts of the interior of the case, and to permit the passage of a lantern if required. The cover should be secured with screws and not with nails. Attention is especially called to the fact that packing cases should not be lined with paper. Such a lining prevents the circulation of air, and if the machine is packed in a damp atmosphere, the humidity, which under other circumstances would have evaporated, will attack the finished parts, however slightly exposed. Special attention is called to this point, because experience has demonstrated that injurious results frequently occur. Finished parts must be carefully protected with a coating for preventing rust, as often the machines are subjected to rain, and always to dampness, and a machine may remain during many months in a warehouse before being unpacked. Unless finished surfaces are carefully protected by a coating, injury is almost certain.

The subject of proper packing was treated at length in an article in MACHINERY, April, 1904, by Mr. Paul Roux, and we refer to this for more detailed statements. The previous notes, however, give the most important points, and cannot be too strongly impressed upon exporters of machinery, particularly such as are not engaged in a very large exporting business, and consequently more or less unfamiliar with the conditions and requirements.

CENSUS OF METAL-WORKING MACHINERY.

Bulletin 67, Department of Commerce and Labor.

The census of metal-working machinery, 1905, prepared by Mr. Fred. J. Miller, expert special agent, gives a comprehensive view of the extent and the distribution of the manufacture of metal-working machinery in the United States. The term "metal-working machinery" does not include machines or tools for use in the hand trades, such as plumbers' and tinsmiths' tools, and watchmakers' lathes and tools, or rolling mill machinery, cranes, hoists, etc., but merely what is ordinarily termed machine tools and small tools. The last census of this kind was taken in 1900, and the report gives a comparison of the figures in that year with those in 1905, and also states the percentage of increase of the value as well as of the number of machines being built. The greatest production of metal-working machinery at the census of 1905, which, in fact, records the figures for the year 1904, was reported for Ohio, which state also stood first in 1900. The value of metal-working machinery manufactured in Ohio forms not less than 25 per cent of the total value of all metal-working machinery manufactured in the United States, and is greater than the combined product of New York, New Jersey and Pennsylvania. As is well-known, this industry in Ohio is concentrated in Cincinnati and Cleveland, which two cities together produced three-fourths of the total value of all metal-working machinery in the state, or nearly one-fifth of all the metal-working machinery manufactured in the United States. Cincinnati is the leading city in the country in this industry, producing, as it does, almost exactly one-tenth of all the metal-working machinery of the country. Massachusetts is the second state in the union in regard to the value of its machinery products, Worcester being the leading city in that state. Connecticut takes the third place, the leading manufacturing city for this class of machinery being Hartford. New York State takes the fourth place, and New York City is the third city in the United States in regard to the value of production, the bulk of its manufacture being located in Brooklyn. Pennsylvania, which was the second state in the manufacture of metal-working machinery in 1900, sunk to the fifth rank in 1905, but Philadelphia retained its fourth place amongst the cities of the United States. The fifth city in this respect is Providence, producing 86.2 per cent of all the machinery of Rhode Island, which is the seventh among the states of the country in this industry, the sixth place being held by Illinois.

In regard to the class of machinery manufactured, the census shows that while lathes are the principal class of metal-working machinery the value of this product as well as the number of machines decreased most remarkably during the five years since the last census. Ohio ranked first in the production of lathes, reporting about one-third of the total number and more than two-fifths of the total value. The production of milling machines showed a slight decrease in regard to the number of machines manufactured, but there was an increase in the value of such machines of 14 per cent. Rhode Island and Ohio ranked first as the leading states in the manufacture of these machines. A remarkable increase is shown under the heading "All other metal-working machinery not specified," which includes small tools, chucks, precision tools, and special machines for duplicate parts. The total value for small tools for metal-working machinery manufactured in the United States in 1904 was more than one-seventh of the total for all classes of metal-working machines. In the census, only tools for use in power-driven machinery are reported as small tools, but it is possible that some hand tools have been included. However, as there may be some manufacture of this class of apparatus not reported, it is probable that the figure given is a fairly accurate report of this branch of manufacture. The value of special machinery for the manufacture of duplicate parts, and special machinery not specified, amounted to more than one-tenth of the total of all metal-working machinery. Massachusetts was the principal state in the manufacture of small tools, and also in precision tools and machines, with Connecticut second in rank in the former, and Rhode Island in the latter manufacture.

If the foreign trade in iron and steel manufacture and machinery may be taken as an index of the condition prevailing in the various branches of that industry, the figures of the census clearly show that the manufacture of metal-working machinery was somewhat depressed during the five-year period recorded by the census. The exports of iron and steel manufacture and machinery decreased steadily, year by year, from 1900 to 1903 inclusive, and although in 1904, when the business conditions in this country were improving in the iron and steel industry, the increase in exports was materially greater than the years preceding, the exports in that year still were considerably less than those of 1900.

While the total production of metal-working machinery in the census of 1905 shows an increase as compared with the census of 1900, it must be remembered that the statistics of the latter year were not as complete as those of the former.

GAS ENGINE POWER CHART.

L'Automobile, July 29, 1905.

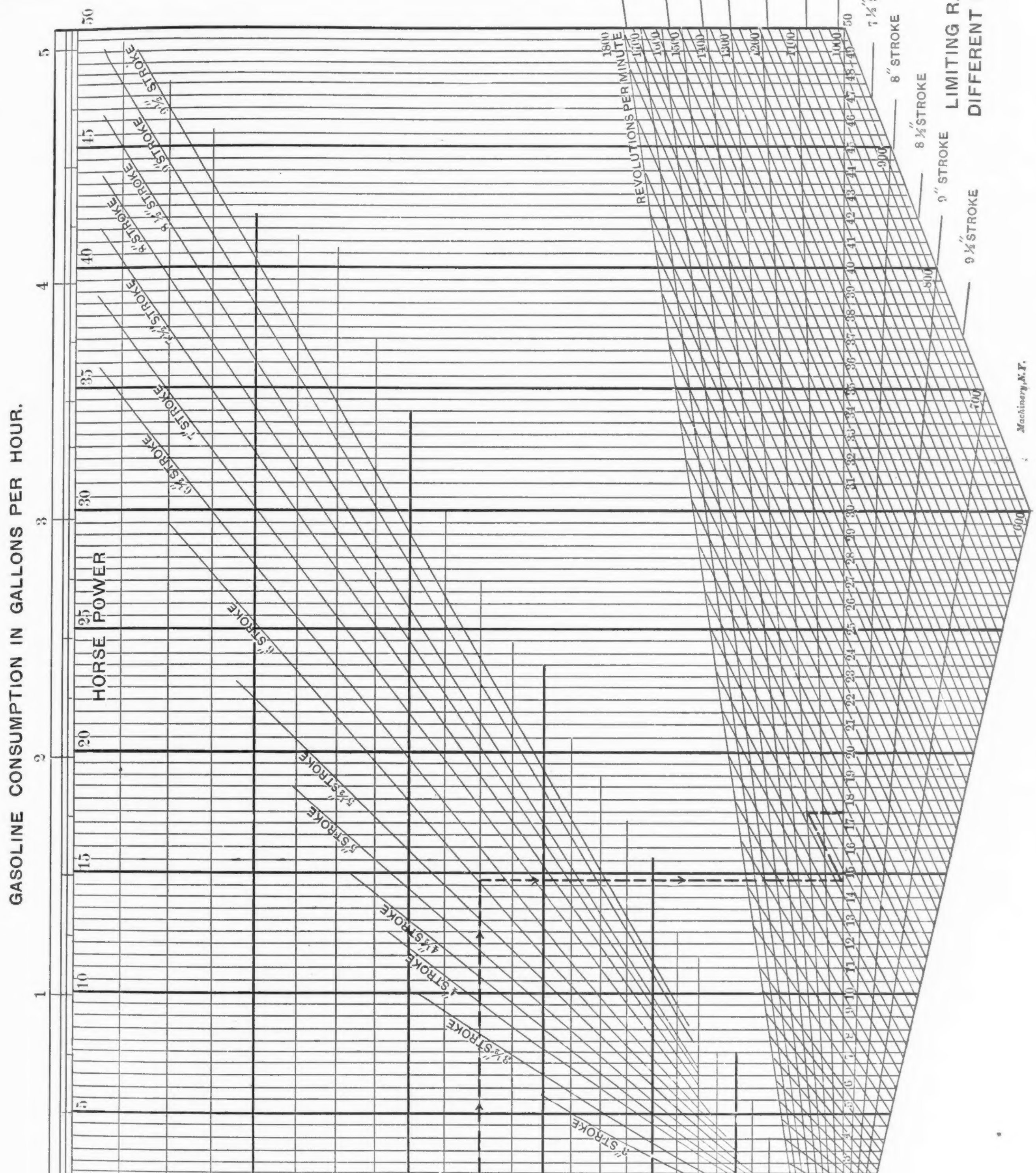
The accompanying chart is of great value to a gas engine man as it enables him to quickly arrive at the power of a motor. The original curves were given with bore, stroke, horse-power, gasoline consumption, etc., in metric denominations; these have been transposed into English equivalents.

The bores (in inches) are represented by ordinates at the left-hand side (straight horizontal lines), including diameters from 2½ to 7¾ inches. The stroke of the motor is shown by the curves in the top section of the diagram, which include from 3 to 9½ inches. The revolutions per minute (R.P.M.) are shown by a series of diagonal lines in the lower section of diagram, numbered 600 to 1,800, inclusive. There is for a motor a limit of R.P.M. above which the horse-power does not increase proportionally to its R.P.M. To this end the diagram shows on the right the limit of the R.P.M. corresponding to the different strokes. Thus, the results of this table are accurate only for a motor with a 5½-inch stroke from 600 R.P.M. up to 1,300 R.P.M., the limit 1,300 R.P.M. being read opposite "5½-inch stroke" in the lower right-hand corner. The method of using the table is as follows:

Given: The bore, 5½ inches; stroke, 6 inches of a four-cylinder engine. To find the maximum horse-power and normal amount of gasoline consumed per hour.

First find the maximum R.P.M. for the given stroke by looking opposite the stroke 6 inches in the lower right-hand corner. This will be found to be about 1,200 R.P.M. Follow the horizontal line corresponding to 5½-inch bore until it intercepts the curve corresponding to 6-inch stroke. From this point draw a perpendicular down to the H.P. line (1,000 R.P.M.) when we read by interpolation 14.6. The line corresponding to 1,200 R.P.M. (the maximum) is above the 1,000 R.P.M. or H.P. line, so follow the diagonal line from the point

14.6 *upward* and to the *right* until it intercepts this 1,200 R.P.M. line, where drawing a perpendicular line again to the H.-P. line, from this intersection, will give us approximately 17.5 H.P. for one cylinder at 1,200 R.P.M. For the four cylinders, multiply by 4, arriving at 70 H.P.



At the top of the diagram perpendicularly above the 17½ H.P., we find 1.8 gallon per hour gasoline consumption, which multiplied by 4 gives 7.2 gallons per hour.

If the power of this motor were wanted at 700 R.P.M. instead of 1,200, follow a diagonal line *down* and to the *left* from the point 14.6 on the H.P. or 1,000 R.P.M. line, and at its intersection with the 700 R.P.M. line go perpendicularly upward again to the H.P. line, arriving at 10.3 H.P. for one cylinder; $10.3 \times 4 = 41.2$ H.P. for four cylinders.

The same process is followed with any dimension of cylinder within the limits of this table, arriving at fairly accurate results.

Of course these curves are limited to gasoline motors of the four-cycle type, which run at a moderately high speed or, in other words, will give the average practise for modern motor car and motor boat engines. It will also be understood that the H.P. of different motors by different makers, and even the same makers, will vary, due to different points in design, setting of valve and ignition cams, carburation, etc., as much as 5 per cent above and below the results arrived at through the use of this diagram. The diagram was made to be read with the left side (as here shown) at the top, and the directions are worded for this more convenient position when in use.

L. R. G.

A PLEA FOR HEALTHFUL CONDITIONS IN THE BRASS INDUSTRY.

Paper read by Mr Walter B. Snow before the American Foundrymen's Association Convention, Philadelphia, May 21-23, 1907.

In much of the early work done for the welfare of the employe there was a strange confusion of motives. But out of this confusion has now grown a definite recognition of the purely economic advantages of surrounding the workman with healthful conditions. While some other industries are more directly harmful to the health than is the brass industry, there is, nevertheless, ample opportunity within its field to greatly improve the conditions. While the heat and the fumes are primarily uncomfortable, and only secondarily injurious, the greatest harm is done by the dust which is inhaled. This dust is usually of mineral or metallic origin, resulting from the grinding, polishing, tumbling and sandblasting processes

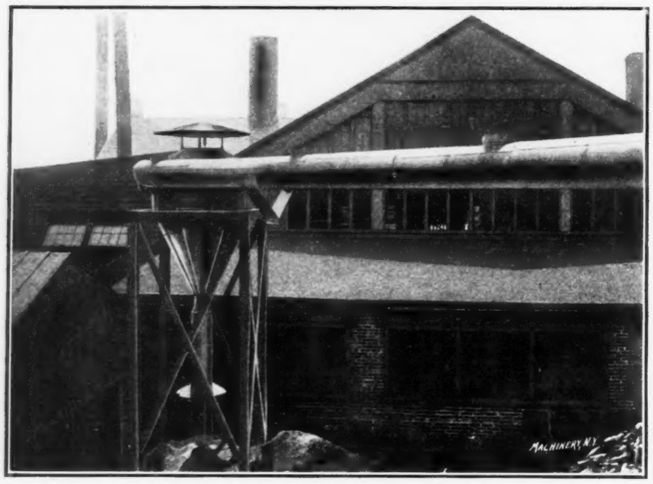


Fig. 1. Dust Collector Discharging into Open Yard.

It is commonly recognized that life is shortened by working in a dust-laden atmosphere, but the extent to which some industries are injurious is startling. In the cutlery and tool industry, which is declared to be one of the most dangerous of trades in this class, the average age of the operatives at death is exceedingly low, and in establishments conducted without proper hygienic precautions, sound men are rare after a few years' work. The prevailing cause of death is consumption, which usually overtakes a susceptible worker so early that his period of usefulness does not extend much beyond five or six years, except where the health is properly safeguarded. The testimony of physicians is that of those employed in this industry nearly all who reach the age of forty die of consumption, excepting those who succumb to some acute disease. As proof of this statement, it is instructive to note that in Northampton, Mass., an important seat of the cutlery industry, the death rate from tuberculosis for the entire male adult population was 2.9 per thousand, while that for the cutlers of that town was four times as great, or 11.8 per thousand. The trouble lies not so much in any directly poisonous results from inhaling the dust as in its power to bring about constant irritation, which produces such a condition of the mucous surfaces that they more readily admit of invasion by disease germs. Fortunately, brass is less irritating than steel, and consequently the results in the brass industry are not as disastrous as they are among the cutlers. But the dust of corundum and emery is peculiarly irritating, and the brass workers' surroundings are therefore susceptible of marked improvement.

The unhygienic conditions existing in the various industries have received the attention of State Boards of Health, whose official investigations are bringing about the passage and enforcement of more stringent laws looking to the safeguarding of the health of the employes in all industrial establishments. In a word, advance has been made from a matter of individual interest to one of almost national importance. The statute books of the leading states of the Union already contain laws, usually somewhat vague in their expression, which require cleanliness, light, warmth, ventilation, and the introduction of specific devices for removing dust, fumes, and the like. While the first impulse of the manufacturer may be to resent the enactment of further laws, yet his compliance with them is not without eventual advantage. Not only will a better class of men prefer to work for him if improved conditions are provided, but there will be far less interference with work because of sickness, more energy in the work which is done, and less loss by death of the potential value possessed by the man who has become thoroughly skilled in a given line of work. Continued sickness and death naturally mean constant replacement of individuals, with the loss of knowledge and skill gained by those who have gone. As a result there is far less stability of labor conditions in an unhealthy industry.

Experience has shown, and the reports of investigations confirm the fact, that mechanical means are absolutely necessary to maintain a rapid air change or to insure proper removal of dust. In fact, the fan blower figures everywhere as the only device adapted to secure these results. It is manifest that the action must be positive, and of sufficient intensity to create ample movement of air. Where there is but little dust or the requirements of ventilation are slight, a fan applied for mere renewal of air throughout the entire extent of a room will meet the requirements. When warranted by the size of the plant, the fan may form part of a blower heating system, by means of which warm air from a centralized heater is delivered under pressure through pipes to all parts of the building. In overheated rooms, and particularly for summer ventilation, the disk or propeller type of fan meets the requirements if placed in wall or ceiling. Wherever dust or fumes are formed locally, as in connection with grinding and polishing wheels, tumbling barrels, or furnaces, the exhaust should be direct from hoods which enclose the objectionable source as completely as possible. In a word, prevention is better than cure. The objection which is often shown by workmen to hoods and similar contrivances, even to the extent of actual destruction, is largely due to their improper construction. In fact, the cause for condemnation or criticism of many exhausting systems lies in the method of application of the fan, and not in the fan itself. The success of the fan not only depends upon its speed and its proper proportioning to the work, but also upon the system of piping and hoods which would give the greatest efficiency. It seems so simple to employ a local tinsmith to rig up an exhausting system that it is not strange that unsatisfactory conditions result. It is far better policy, however, to secure the best advice, which will always be freely given by blower manufacturers, and then have the thing done right. It must not be overlooked that the installation of an economical exhausting arrangement requires definite engineering ability, and experience in this particular class of work.

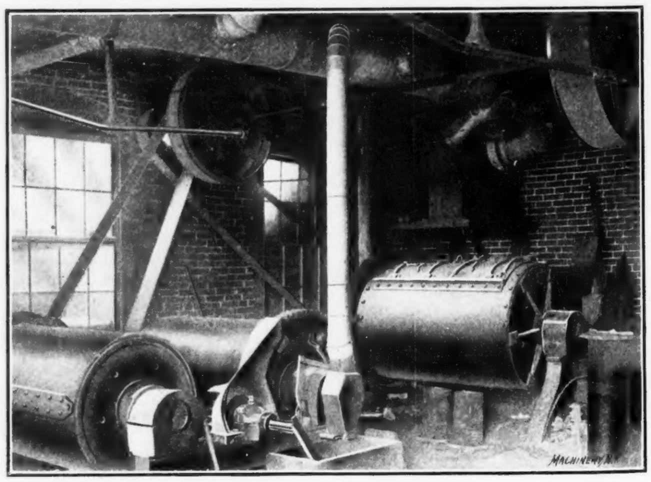


Fig. 2. Exhaust System for Tumbling Barrels.

Because of the lower first cost, the user is always strongly tempted to buy the smallest apparatus that can be made to do the work. But first cost is only one of the factors in the total cost. Large, slow running fans with ample pipe areas are conducive to small power expenditures. It is easy to save enough in power in six months to pay the additional cost of a more efficient outfit or system. Thereafter its economy is all clear gain. Even though the fan be of ample size when first installed, it may, as a result of speeding up to meet added re-

quirements, frequently demand from 50 to 100 per cent more power than would be necessary to do the work with a proper outfit. It is none too generally understood that the power required to drive a fan increases as the cube of the speed; in other words, that doubling the speed calls for an eight-fold increase in power, while twenty-seven times the power is required at three times the speed; an increase of only 25 per cent in speed calls for nearly double the power, and yet such an increase is common enough. How long would it take to pay for a new outfit from the money thus squandered in power?

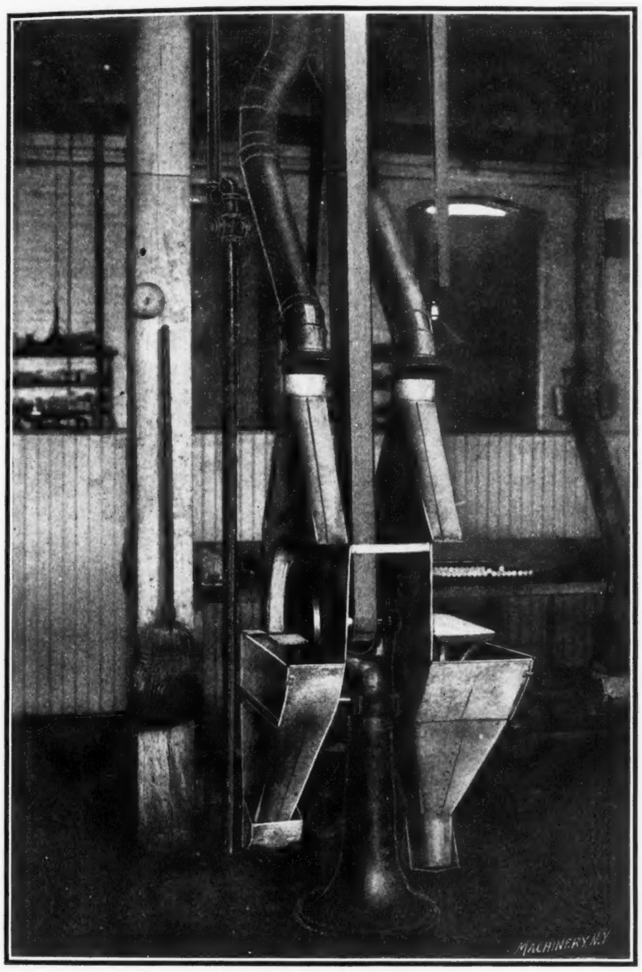


Fig. 3. Exhaust Hoods on Disk Grinder.

The designs of hoods for grinding, polishing, or buffing wheels are many and varied. Each must be arranged to suit the particular class of work for which the wheel is used. In some cases it is even necessary to have several different types in the same room. This is true where the pieces are of such shape and size that it is impossible to get very close to the wheel, the result being that at one time the operator uses the wheel at a point near the top, and again at a point directly underneath. Under these conditions especial care must be taken to provide the most effective type of hood and maintain the maximum blast. In heavy work of this type the air suction pipe should be 5 inches in diameter for wheels up to and including 16 inches in diameter by 3 inches face. In ordinary grinding and buffing rooms the suction pipes should be 4 inches diameter for wheels $2\frac{1}{2}$ inches or less in width and from 10 to 18 inches in diameter. Wheels ranging from 19 inches to 28 inches should have 5-inch or 6-inch pipes according to class of work for which they are used. All hoods should be so designed that the velocity through the openings should not be less than 5,000 feet per minute, which is usually sufficient to create the draft necessary to carry away the particles. The best general type of hood is provided with a receptacle below to trap out all heavy particles, as well as the threads from the buffing wheels, while allowing the finer dust to pass through the pipe. The result is that the metallic particles are left in clean condition ready for resmelting, and the wear on the pipes and the fan is greatly reduced. This arrangement also prevents the annoyance caused by the dust from the rag wheel adhering to the fan wheel and throwing it out of balance. The trapping-out feature, furthermore, permits of the ready recovery from the bottom of the hood of any small piece of work or other material, which with other types of hoods might get into the main trunk line or up into the fan. All properly designed systems should have clean-cut caps so as to provide free access to the interior of the piping. The main suction pipe should be proportionally increased in size as each connection is made to it.

To secure the most economical results, a fan should be chosen which has an area of inlet about twice the combined area of the inlet pipes. This proportion will give the maximum velocity through the branch pipes and hoods. The fan should then be operated at about $1\frac{1}{2}$-ounce speed, under which condition it would consume about $\frac{1}{2}$ horse-power for each 4-inch opening. The most work is done, and consequently the most power is required, by a fan when it is discharging with free inlet and outlet. The more extended the system of piping, the smaller the area of inlet or outlet; and the greater the friction, the less will be the volume delivered by the fan; and consequently the less will be the power required to drive it. It is therefore manifest that the fact that the fan is consuming but little power is not always evidence of its successful operation, for it may be doing little effective work. The dust which is collected by the fan should be discharged into a centrifugal dust collector. Here the dust is separated from the air by centrifugal force; the air escapes from the top practically free from dust, while the dust itself drops out of the bottom through a pipe. It should be periodically removed. The dust from wheels grinding iron and steel should not be mixed with that from rag wheels, for in some cases fire will result. Separate fans and systems should be used.

The same general principles hold in connection with systems exhausting from tumbling barrels. If the maximum effect of the fan is desired on tumbling barrels equipped with hollow trunnions, the area of fan inlet should be about double that of the sum of the openings in the trunnions. The sizes of pipes and the speeds of fans to be applied in connection with housed rattlers must depend largely upon the conditions, but a 6-inch pipe connection will usually serve for each tumbling barrel, if the same is tightly enclosed. A fan running at about 1 ounce speed, will give sufficient draft. No general rules can be given for the application of the fan system to sandblast rooms or apparatus. The arrangement must depend entirely upon local conditions. With installations such as are here described, it is possible to maintain a relatively healthy atmosphere, which is bound to insure better work, and there is certainly no reason why healthful conditions should not be found wherever the brass industry is pursued.

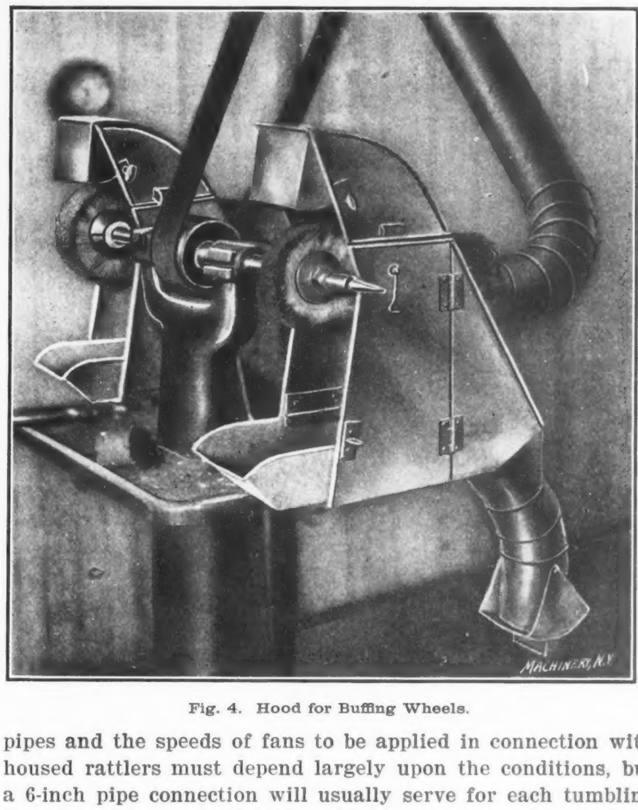


Fig. 4. Hood for Buffing Wheels.

ON THE ART OF CUTTING METALS.—7.*

FRED. W. TAYLOR.

COOLING THE TOOL WITH HEAVY STREAM OF WATER.

Cooling the nose of a tool by throwing a heavy stream of water or other fluid directly upon the chip at the point where it is being removed by the tool from the steel forging enables the operator to increase his cutting speed about 40 per cent. The economy realized through this simple expedient is so large that it is a matter of the greatest surprise that experimenters on the art of cutting metals have entirely overlooked this source of gain. In spite of the fact that (as a result of our experiments) the whole machine shop of the Midvale Steel Company was especially designed as long ago as 1893 for the use of a heavy stream of water (supersaturated with soda to prevent rusting) upon each cutting tool, until very recently practically no other shops in this country have been similarly equipped. The following are the important conclusions arrived at as to the effect on the cutting speed of cooling the tool with a heavy stream of water.

A. With high speed tools a gain of 40 per cent can be made in cutting steel or wrought iron by throwing, in the most advantageous manner, a heavy stream of water upon the tool.

B. A heavy stream of water (3 gallons per minute) for a 2-inch by 2½-inch tool and a smaller quantity as the tool grows smaller, should be thrown directly upon the chip at the point where it is being removed from the forging by the tool. Water thrown upon any other part of the tool or the forging is much less efficient.

C. The gain in cutting speed through the use of water on the tool is practically the same for all qualities of steel from the softest to the hardest.

D. The percentage of gain in cutting speed through the use of water on the tool is practically the same whether thin or thick chips are being removed by the tool.

E. With modern high-speed tools a gain of 16 per cent can be made by throwing a heavy stream of water on the chip in cutting cast iron.

F. To get the proper economy from the use of water in cooling the tool, the machine shop should be especially designed and the machine tools especially set with a view to the proper and convenient use of water.

G. In cutting steel, the better the quality of tool steel, the greater the percentage of gain through the use of a heavy stream of water thrown directly upon the chip at the point where it is being removed from the forging by the tool. The gain for the different types of tools in cutting steel is:

a. Modern high-speed tools, 40 per cent;
b. Old style self-hardening tools, 33 per cent;
c. Carbon tempered tools, 25 per cent.

This fact, stated in different form, is that the hotter the nose of the tool becomes through the friction of the chip, the greater is the percentage of gain through the use of water on the tool.

The Portion of the Tool upon which the Water Jet should be Thrown.

A series of experiments has demonstrated that water thrown directly upon the chip at the point where it is being removed from the forging by the tool will give higher cutting speeds than if used in any other way.

As another illustration of the small value to be attached to theories which have not been proved, we would cite the following: After deciding to try experiments upon the cooling effect of water when used upon a tool, it was our judgment that if a stream of water were thrown upward between the clearance flank of the tool and the forging itself, in this way the water would reach almost to the cutting edge of the tool at the part where it most requires cooling, and that, by this means the maximum cooling effect of the water would be realized. We, therefore, arranged for a strong water jet to be thrown, as shown in Fig. 46, between the clearance flank of the tool and the flank of the forging, and made a series of experiments to determine the cooling effect of water with various feeds and depths of cut. So confident were we of the truth of this theory that we did not deem it worth while to experiment with throwing streams of water in any other way, until months afterward, when upon throwing a stream of water upon the chip directly at the point where it is being removed from the forging by the tool, we found a material increase in the cutting speed, and thus our first experiments were rendered valueless. Practically, great difficulty will be found in getting machinists in the average shop to direct the stream of water on to the chip in the proper way as indicated in Fig. 47, because when a sufficiently heavy stream of water is thrown upon the work at this point, it splashes much more than when thrown upon the forging just above the chip; and the machinists prefer slower cutting speeds and less splash.

* Abstract of paper read before the American Society of Mechanical Engineers December, 1906.

Forty Per Cent Gain in Cutting Speed from Throwing a Heavy Stream of Water upon the Tool in Cutting Steel.

It has been customary for many years to use under certain circumstances, a small trickling stream of water upon cutting tools (mostly on finishing tools, and with the object of giving the work what is called a "water finish"). For this purpose a small water can is generally mounted upon the saddle of the machine above the tool, and refilled from time to time by the machinist. Such streams of water, however, have little or no effect in increasing the cutting speed, because they are too small in volume to appreciably cool the nose of the tool.

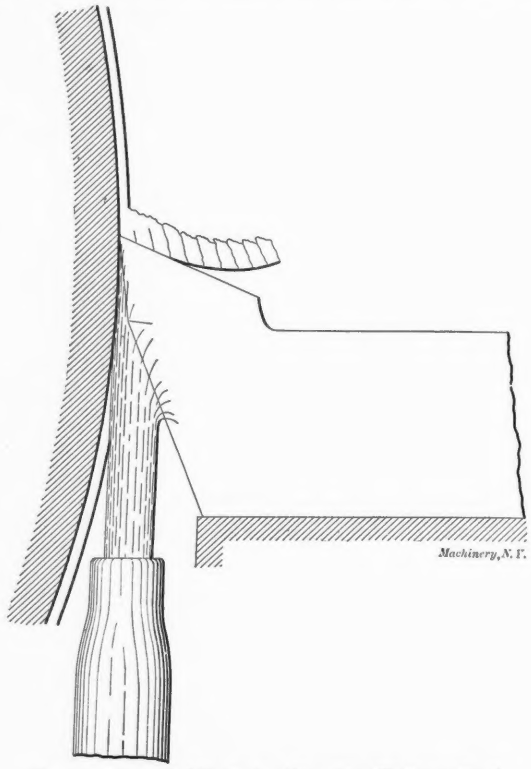


Fig. 46. Discarded Method of Throwing Water on Tool.

The most satisfactory results are obtained from a stream of water falling at rather slow velocity, but with large volume, at the proper point upon the tool, since a stream of this sort covers a larger area of the tool and is much freer from splash.

This water supply should be delivered through pipes fitted up with universal friction joints, so that the apparatus can be quickly adjusted to deliver the water at any desired point (the pipe being supported by a rigid bracket attached to the saddle of the lathe, preferably on the back side so as to be out of the way). In the case of short lathe beds the water supply can be delivered from overhead through a rubber hose, and in the case of long lathe beds through telescoping pipes attached to the saddle (smooth drawn brass pipes telescoping inside of ordinary wrought iron pipes, with suitable stuffing boxes, being used).

About three gallons of water per minute are required for adequately cooling a very large roughing tool, say, 2 inches by 2½ inches section, and proportionally smaller quantities as the tool grows smaller.

For economy, the same water should be used over and over again, and it should be supersaturated with soda to prevent the machines from rusting. Wrought iron pipes about 1¼ inch diameter should lead the water from beneath the machine below the floor to the main soda water drains at the side of the shop. These drains are made of pipe from 3½ to 5 inches in diameter, with a chain extending through them

from one end to the other, the chain being twice as long as the drain through which it extends. In case of sediment forming in this pipe, or in case of chips passing by the double sets of screens and double settling pots which should be supplied at each machine, the drain can be quickly cleaned by pulling the chain once or twice backward and forward through it.

The soda water is returned through this system of underground piping to a large central underground tank, from which it is pumped through a small, positive, continuously running pump, driven by the main line of shafting, into an overhead tank with overflow which keeps the overhead soda water supply mains continually filled and under a uniform head. If the shop is constructed with a concrete floor, a catch basin for the water can be molded in the concrete, directly beneath each machine. Otherwise, each machine should be set in a large wrought iron pan or shallow receptacle which catches the soda water and the chips. In both cases, however, two successive settling pots—independently screened so as to prevent the chips, as far as possible, from getting into the return main—are required beneath each machine.

The ends of the 1¼-inch wrought iron pipes which lead the water from the machines to a large drain at the side of the shop should be curved up with a sweeping curve so that their outer ends come close to the top of the floor of the shop. The sediment and chips must be cleaned from these pipes from time to time by means of a long round steel rod from ⅜ to ½ inch in diameter, which, after removing the plug at the outer end of the drain pipes, is shoved through the pipe. Apparatus of this type has been in successful use for about 23 years with no trouble from clogging.

Chatter of the Tool.

The following are the general conclusions arrived at on the subject of chatter of the tool:

A. Chatter is the most obscure and delicate of all problems facing the machinist, and in the case of castings and forgings of miscellaneous shapes probably no rules or formulas can be devised which will accurately guide the machinist in taking the maximum cuts and speeds possible without producing chatter.

B. It is economical to use a steady-rest in turning any piece of cylindrical work whose length is more than twelve times its diameter.

C. Too small lathe-dogs or clamps, or an imperfect bearing at the points at which the clamps are driven by face-plate, produce vibration.

D. To avoid chatter, tools should have cutting edges with curved outlines, and the radius of curvature of the cutting edge should be small in proportion as the work to be operated on is small. The reason for this is that the tendency of chatter is much greater when the chip is uniform in thickness throughout, and that tools with curved cutting edges produce chips which vary in thickness, while those with straight cutting edges produce chips uniform in thickness.

E. Chatter can be avoided, even in tools with straight cutting edges, by using two or more tools at the same time in the same machine.

F. The bottom of the tool should have a true, solid bearing on the tool support which should extend forward almost directly beneath the cutting edge.

G. The body of the tool should be greater in depth than its width.

Chatter caused by modifications in the machine may be classified as follows:

H. It is sometimes caused by badly made or fitted gears.

J. Shafts may be too small in diameter or too great in length.

K. Loose fits in the bearings and slides may occasion chatter.

L. In order to absorb vibrations caused by high speeds, machine parts should be massive far beyond the metal required for strength.

The Effect of Chatter upon the Cutting Speed of the Tool.

M. Chatter of the tool necessitates cutting speeds from 10 to 15 per cent slower than those taken without chatter, whether tools are run with or without water.

N. Higher cutting speed can be used with an intermittent cut than with a steady cut.

Of all the difficulties met with by a machinist in cutting metals, the causes for the chatter of the tool are perhaps the most obscure and difficult to ascertain, and in many cases the remedy is only to be found after trying (almost at random) half a dozen expedients. This paper is chiefly concerned with chatter as it is produced or modified by the cutting tool itself. Some of the other causes for chatter, however, may be briefly referred to. These may be divided into five groups:

A. The design of the machine;
B. The nature and proportions of the work being operated upon;
C. The care and adjustment of the parts of the machine;
D. The method of setting the work in the machine or of driving it;
E. The shape of the cutting tools, manner in which they are set in the machine, and the speeds at which they are run.

Causes *A* and *B* are outside the control of the machinist. Elements *C*, *D* and *E* are, or should be, to a large extent under the control of the management of the shop.

A. Referring, now, to cause *A*, "The design of the machine," the chief elements causing chatter in the design of a machine are:

Aa. Gears which are set out of proper adjustment, or the teeth of which are untrue. It should be noted that involute teeth will run smoothly whether their pitch diameters exactly coincide or not, whereas the epicycloidal teeth are almost sure to rattle unless their pitch lines are maintained in their exact proper relations one to the other.

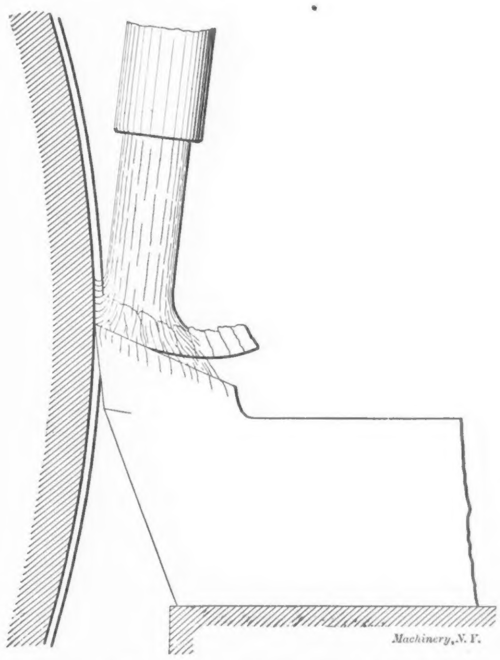


Fig. 47. Method of Throwing Water on Tool, Giving the Best Results.

Ab. Chatter is frequently caused through mounting the driving gears upon shafts which are either too small in diameter or too long. A large excess in the diameter of shafts beyond that required for strength is called for in order to avoid torsional deflection which produces chatter.

Ac. Lathe shafts and spindles must of course be very accurately and closely fitted in their bearings, and the caps adjusted so as to avoid all play.

Ad. For heavy work the lathe tail-stocks should be fastened to the bed plates with bolts of very large diameter, and should be tightened down with long handled wrenches.

Ae. The lathe bed itself should be exceedingly massive, and should contain far more metal than is required for strength, or even to resist ordinary deflections; and the moving tool supports should also be heavy far beyond what is required for strength.

Massive Machines Needed for High Speeds.

Undoubtedly high cutting speeds tend far more than slow speeds toward producing minute and rapid vibrations in all parts of the machine, and these vibrations are best opposed and absorbed by having large masses of metal supporting the cutting tool and the head- and tail-stocks. It is largely for the purpose of avoiding vibration and chatter in machines that the high cutting speeds accompanying the modern high speed tools call for a redesigning of our machine tools. While it is true that in many cases a very great gain can be made by merely speeding up a machine originally designed for slow

speed tools, this increase in speed almost invariably produces a corresponding increase in the vibration or chatter, and for absorbing this, the lathes and machines of older design are, in many cases, too light throughout.

B. Cause *B*, namely, "The nature and proportions of the work being operated upon." In assigning daily tasks to each machinist with the help of our slide rules, the element which still continues to give the greatest trouble to the men who write out these instructions is deciding just how heavy a cut can be taken on the lighter and less rigid classes of work without causing chatter. This branch of the art of cutting metals has received less careful and scientific study than perhaps any other. While the element is one which must always remain more or less under the domain of "rule of thumb," since the causes which produce chatter, particularly in castings of irregular shapes, are so many and complicated as to render improbable their successful reduction to general laws or formulas, undoubtedly much can be done toward attaining a more exact knowledge of this subject, and experiments in this line present a most important field of investigation.

The following rule (belonging to the order of "rule of thumb") which has been adopted by us after much careful and systematic observation, extends over work both large and small, and covers a wide range: *It is economical to use a steady-rest in turning any piece of metal whose length is more than twelve times its diameter.* When the length of a piece becomes greater than twelve times its diameter, it is necessary to reduce the size of the cut to such an extent that more time will be lost through being obliged to use a light cut than is required to properly adjust a steady-rest for supporting the piece.

C. Cause *C* namely, "The care and proper adjustment of the various parts of the machine" is almost entirely under the control of the shop management. It is of course evident that so far as the effect of chatter is concerned, one of the most important causes can be eliminated from the shop by systematically looking after the careful adjustment of all of the working pasts of the machine to see that the caps of the bearings are always so adjusted as to have no lost motion and yet not bind, and so that all gibs and wedges for taking up wear upon the various slides are kept adjusted to a snug fit. It is our experience, however, that the adjustment of the various parts of the machine should in no case be left to the machinist who runs his lathe, but that the adjustment and care of machines should be attended to systematically and at regular intervals by the management. In large shops a repair boss with one or two men can be profitably kept steadily occupied with this work.

D. Cause *D*, namely, "The method of setting the work in the machine or of driving it," is in many cases capable of being directly under the control of the machinist.

Da. One of the most frequent causes for chatter lies either in having too light or too springy clamps or lathe dogs fastened to the work for the purpose of driving it, or in having vibration at the point of contact between the lathe dog and the face-plate of the lathe, or the driving bracket, which is clamped to it. In heavy work the clamps should be driven at two points on opposite sides of the face-plate, and great care should be taken to insure a uniform bearing of the clamps at both of these driving points. Chatter through vibration at this point can frequently be stopped by inserting a piece of leather or thick lead between the clamps and the driving brackets on the face-plate, which has the effect both of deadening the vibration and equalizing the pressure between the two outside diameters at which the clamp is driven by the face-plate.

Db. A dead center badly adjusted so as to be either too tight or too loose on the center of the work, or any lost motion in the tail-stock of the lathe is such an evident source of chatter that it need not be dwelt upon.

E. Cause *E* namely, "The shape of the cutting tools, the manner in which they are set in the machine and the speeds at which they are run." We have attempted to explain the effect of a uniform thickness of chip in causing chatter, and have indicated that the proper remedy for this is to use a round-nosed tool, which is always accompanied by a chip of uneven thickness. We have also referred to the desirability of having the body of tools deeper than their width in order to insure strength as well as to diminish the downward deflection of the tool, which frequently results in chatter, particularly when the tools are set with a considerable overhang beyond their bearing in the tool-post. We have also called attention to the great desirability of designing tools with their bottom surfaces extending out almost directly beneath the cutting edge, and of truing up the bottom surface of the tools, so as to have a good bearing directly beneath the nose of the tool on the tool support. If sufficient care is taken in the smith shop, and the smith is supplied with a proper surface plate, the tools can be dressed so as to be sufficiently true on their bottom surfaces for all ordinary lathe work.

It has been the necessity for avoidance of chatter which has influenced us greatly in the adoption of round-nosed tools as our standard. Tools with straight cutting edges, which remove chips uniform throughout in thickness can be run at very much higher cutting speeds than our standard round-nosed tools; but owing to the danger of chatter from these tools, their use is greatly limited, in fact, almost restricted to those special cases in which chatter is least likely to occur. Attention should be called, however, to a method by which straight edge tools have been used successfully for many years upon work with which there was a very marked tendency to chatter.

While at the works of the Midvale Steel Company we superintended the design of a large lathe for rough turning gun tubes and long steel shafts, in which tools with long, straight cutting edges were used without chatter, and yet at the high speeds corresponding to the thin chips which accompany this type of tool. This lathe was designed with saddle and tool-posts of special construction, so that two independently adjustable tool supports were mounted on the front side of the lathe and one on the back side. In each of these slides a heavy straight-edge tool was clamped. The three tools were then adjusted so that they all three removed layers of metal of about equal thickness from the forging, and, although the tendency toward chatter owing to the uniform thickness of the chip was doubtless as great with these straight-edge tools as with any others, the period of maximum or of minimum pressure for all three tools never corresponded or synchronized so that when one tool was under maximum pressure, one of the others was likely to be under minimum pressure. For this reason the total pressure of the chips on all three tools remained approximately uniform and chatter from this cause was avoided.

There is one cause for chatter which would seem to be impossible to foresee and to guard against in advance, *i.e.*, chatter which is produced by a combination of two or more of the several elements likely to cause chatter. If, for instance, the natural periods for vibration in the tool and in the work or in any of the parts of the lathe and the work happen to coincide or synchronize, then chatter is almost sure to follow; and the only remedy for this form of chatter seems to lie in a complete change of cutting conditions; a change, for instance, to a coarser feed with an accompanying slower cutting speed, or *vice versa*. Unfortunately, for economy, higher speeds rather than slow speeds tend to produce this type of chatter, and the remedy therefore generally involves a slower cutting speed.

Higher Cutting Speed Can be used with an Intermittent Cut than with a Steady Cut.

An intermittent cut has a very different effect upon cutting speed from that produced by chatter. We have observed in a large number of cases that when a tool is used in cutting steel with a heavy stream of water on it (and this is the proper method of cutting steel of all qualities), a rather higher cutting speed can be used with an intermittent cut than with a steady one. The reason for this is that during that portion of the time when the tool is not cutting, the water runs directly on those portions of the lip surface and cutting edge of the tool which do the work, and for this reason the tool is more effectively cooled with intermittent work than with steady work. As an example of intermittent work, the writer would cite:

a. Cutting the outside diameter of a steel gear-wheel casting, in which case the tool is only one-half its time under cut;

b. Or turning small pieces of metal which are greatly eccentric;

c. Or, for example, all planer and shaper work which is not too long.

It would seem from a theoretical standpoint that a tool would be greatly damaged (and therefore a slow cutting speed would be called for) by the constant series of blows which its cutting edge receives through intermittent work. It will be remembered, however, that in planer work (and this class of intermittent work comes to the direct attention of every machinist), the tool is more frequently injured while dragging backward on the reverse stroke of the planer than it is while cutting, and it is very seldom that a tool is damaged as it starts to cut on its forward stroke. *In all cases, however, where the tool deflects very greatly, when it starts its cut on intermittent work, slower speeds are called for than would be required for steady work.*

The above remarks on intermittent work do not, of course, apply to cast iron with a hard scale, or the surface of which is gritty. It is evident that in all such cases, owing to the abrasive action of the sand or scale on the tool, intermittent work is much more severe upon the tool than a steady cut.

* * *

TABLES OF DIMENSIONS FOR HUNG BOILERS.

G. L. PREACHER.*

Since the publication of the table of dimensions for hung boilers, which appeared as supplement to the December, 1905, issue of MACHINERY, the writer has received from time to time a number of inquiries from some of those interested in settings of return tubular boilers. These inquiries have been varied, but in all instances the questions asked were relative to installations of more than one boiler in the same setting. As the table above referred to only contains data for single settings (one boiler), a table has been compiled (see Supplement) giving the data necessary for several boilers, so that by the use of the two combined, one would have before him all necessary data for installing any number of boilers.

In ordinary practice, not more than three boilers are ever suspended from a single span of beams, and the table therefore has been worked up for one, two and three boilers. In cases of four boilers, extra columns are generally placed between the two middle boilers, thus making two separate spans of two boilers each. In cases of five boilers, columns are generally placed between the second and third boilers, making two spans of two and three boilers respectively, or additional columns are placed between the fourth and fifth boilers, making three spans of two, two and one boilers respectively. In some instances columns are placed between all the boilers, thus putting only one boiler to a span of beams. Calculations will show this latter arrangement to be the cheapest, for the reason that lighter columns and beams can be used.

In presenting this table the writer wishes to call attention to values calculated under headings: "Total Weight of Boilers and Fixtures," and "Total Weight of Water." It can be readily understood that these values, although based somewhat on experience, are only arbitrary and would vary according to conditions. For instance, a 150 horsepower low-pressure boiler would weigh less than a similar one for high-pressure. The weight of water in the boilers would also depend upon the number and size of tubes and braces occupying the water space. In calculating, therefore, the size beams, columns and hanger bolts for supporting the different size boilers, weights must be determined that will cover all conditions. The values given will be sufficient to calculate from, and although they may seem excessive in some instances, they embody good practice, and the use of smaller ones is not advisable.

* * *

The attendance at the ten highest institutions for technical education in Germany during the winter season 1906-1907 was 15,453, the highest number coming on the Institute of Berlin, where there were 2,375 regular engineering students, besides 754 special students who only took part of special courses.

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SPRING MEETING OF THE A. S. M. E.

The spring meeting of the American Society of Mechanical Engineers was held at the Hotel Claypool, Indianapolis, Indiana, May 28 to 31 inclusive. About 300 persons, including members and guests, were registered. The meeting was enlivened by the Decoration Day exercises, when a bronze statue of General Lawton was unveiled by President Roosevelt. The plants of the Atlas Machine Co., National Motor Vehicle Co., Nordyke & Marmon, Parry Mfg. Co., etc., were open to visitors. The principal visiting event of the week, however, was the visit to Purdue University, on Friday. Special interurban cars were provided for carrying the members and guests to the University over the Indianapolis & Northwestern electric line, connecting Lafayette and Indianapolis. The closing session was held in one of the University buildings. Announcement was made of the election of Andrew Carnegie as honorary member of the society, and of the adoption of two amendments to the constitution. The report by Mr. F. J. Miller stated that the joint obligation of the A. S. M. E. in the land debt is about $200,000, of which $80,000 was paid by the net proceeds from the sale of the old society house at 12 West 31st Street, and $70,000 by subscription, leaving a debt of $50,000 still to be raised. Inasmuch as the annual election of officers takes place just prior to the December meeting, there are no official changes made at the spring meeting.

PARTIAL SYNOPSIS OF PAPERS.

Standard Proportions for Machine Screws.

The committee having this matter in charge presented an amended report, following the suggestions that have been made since the original report was presented at the New York meeting in December, 1905. (See MACHINERY, June, 1906, for abstract.) It has been found advisable to change, except in three instances, the nominal outside diameters for standard sizes of machine screws, and to include in the new list certain additional sizes. The change in the sizes originally proposed vary only from 0.001 to 0.003 inch. The standard diameters adopted are 21 sizes. The pitches are a function of the diameter, and are expressed by the formula:

$$\text{Threads per inch} = \frac{6.5}{D + 0.02}$$

The results are used approximately and in even numbers to avoid fractional or odd numbers of threads. The amended report was adopted.

Pressures of Lap-welded Steel Tubes. By Prof. Reid T. Stewart.

This paper is a supplement to the extensive paper presented by the author at the June, 1906, meeting of the A. S. M. E. While testing the 10-inch tubes, the conditions were found to be such that with the apparatus in use it was practicable to make a series of re-tests on each of these tubes. It was found that the formula,

$$P_2 = 0.0926\,\frac{P_1 - 47.55}{M - 0.874} + 47.55$$

in which,

P_1 = collapsing pressure of normally round tube,

P_2 = collapsing pressure of distorted tube,

M = maximum divided by minimum outside diameters,

is strictly applicable, for the kind of distortion to which it applies, to 10-inch Bessemer steel tubes, 0.15 to 0.20 thickness wall.

Balancing of Pumping Engines. By Mr. A. F. Nagle.

The paper by Mr. Nagle is an account of an investigation as to the proper weight of the plunger of a vertical triple expansion crank and fly-wheel pumping engine. The author concludes that there is no reason why fly-wheels in triple expansion pumping engines should be so very heavy. The turning moments during one revolution do not vary 16 per cent, and an absolute uniform rotative velocity of the wheels is not necessary. With plungers weighted as described in the paper, the author believes that many examples exist where the weight of the fly-wheels of pumping engines could be safely reduced one-half.

Superheated Steam in an Injector. By Mr. Strickland L. Kneass.

In view of the growing use of superheated steam, it was deemed timely to present a few notes on the use of superheated

steam in the injector. Since the injector is a condensing apparatus, it follows that a condition of the steam which retards condensation reduces its efficient mechanical action. Hence the use of superheated steam in injectors is not advisable. It is essential that the condition of the steam permit instant and complete condensation, and that its velocity reach a maximum at the instant of impact with the water. The practical effect of superheated steam on the action of an injector is to reduce the maximum capacity, increase the minimum capacity, and to lower the limiting temperature of the water supply with which the injector can operate. With high pressure and superheat an efficiently designed instrument is likely to become inoperative. Therefore, in all superheated steam plants using injectors for boiler feeders, it is desirable that the injector be supplied with saturated steam.

Flow of Superheated Steam in Pipes. By Mr. E. H. Foster.

From investigations carried on in a large number of steam plants the author has collected certain data which indicate that the laws governing the flow of superheated steam differ appreciably from those governing the flow of saturated steam. A high velocity of superheated steam in pipes is recommended, because there is a smaller percentage of heat loss, and because there is a lower actual drop in temperature. The author recommends for steam pipes of straight runs or easy bends a velocity of 6,000 to 8,000 feet per minute where a superheat of 100 to 299 degrees F. is used.

The Performance of Cole Superheaters. By Prof. W. F. M. Goss.

The author describes the Cole superheater as applied to a locomotive in the locomotive testing laboratory of Purdue University. The results of tests show that the degree of superheat in the steam delivered to cylinders is largely affected by the rate of evaporation. It depends upon the smoke-box temperature, which increases with increased evaporation. Thus, when the temperature of the smoke-box is changed from 600 degrees to 800 degrees F., the heat absorbed in superheat rises from 5.6 to 8.5 per cent of the total taken up by the water and steam. A full analysis of cylinder performance is not given in the paper, but the author intimates that the results noted are clearly satisfactory. Locomotive *Schenectady*, under normal conditions of running before the superheater was attached, developed an indicated horse-power on from 24 to 27 pounds of steam. After being equipped with the superheater the same locomotive delivered, under ordinary conditions of running, an indicated horse-power with a consumption of 20 to 22 pounds of superheated steam per hour, the difference being about 17 per cent.

Superheat and Furnace Relations. By Mr. Reginald P. Bolton.

This paper is a plea for a more intelligent study of the relations of steam boiler furnaces and superheating apparatus. Most of the present practise seems to be based on the adaptation of superheating apparatus to standard forms of boilers and settings, and it has become very common practise to install superheating service in some position in the gas passages, without special regard to the conditions that usually obtain. If existing designs of boilers and settings are to be rigidly adhered to, it would seem that the eventual aim should be in the direction of remodeling designs of both boiler and setting in favor of superheating apparatus. Merely to place a superheating coil in a certain part of the gas passage of a boiler and connect the steam supply to it is by no means to be regarded as a complete solution of the problem. The problem is one in which the designer and manufacturer of every type of boiler is interested, and is one which they cannot be too strongly urged to take in hand.

Air-cooling of Automobile Engines. By Mr. John Wilkinson.

Air-cooled cylinders of automobile engines are likely to become too hot for proper operation. Overheating shows itself in a number of ways. The cylinder may become so hot that the incoming gases expand so much that there is a reduction of power, or the lubricating oil may fail to perform its proper function, causing a great increase of friction, which still further heats the cylinder and reduces its power. The cylinder walls may become so heated that the charge is ignited prematurely. This condition is indicated by energetic knocking. The author points out that the design of cylinders should be such as to reduce to a minimum the amount of heat that is allowed to enter the cylinder walls. For this reason cylinders should not be built with valve pockets on each side of the cylinder, but rather should be made with semi-spherical cylinder heads. For example, the internal surface exposed to heat at the time of expansion in a 4 x 4-inch motor with a semi-spherical cylinder pocket is about 38 square inches; the same size motor with valve pockets on the sides of the cylinder exposes about 74 square inches to the exploded gases. It is self-evident that the loss must be much greater in the latter case. Engines with a semi-spherical head will show a gain of from 25 per cent in power and efficiency over the prevalent type with valve pockets on each side. This type of cylinder head may be machined smooth on the inside and thus reduce its absorbent effect to a minimum. The best internal conditions may be summed up as follows:

a. To present the minimum internal surface to the heat.
b. To make this surface as smooth as possible.
c. To carry off the hot exhaust gases at the bottom of the stroke before the main exhaust valve opens.
d. To get rid of remaining gases with as little surface contact with the cylinder as possible.
e. To reduce friction of piston to a minimum.
f. Keep all the projections out of the cylinder.
g. To make the compression fit all conditions.

Materials for Automobiles By Mr. Elwood Haynes.

This paper is a review of the physical characteristics of nickel steel, nickel-chrome steel, alloy tool steel, vanadium steel, bronze and aluminum. The present requirements of automobiles have greatly improved the quality of steels not obtainable for this and kindred purposes. Bronze is recommended in automobile construction only for parts requiring low rigidity and moderate strength. Aluminum is now used very largely both pure and in alloy form. Alloyed with copper, it has increased hardness and elasticity. Zinc and aluminum form an alloy having considerable rigidity and elasticity and quite high tensile strength. Nickel steel containing from 4 to 5 per cent nickel and less than 0.3 carbon is recommended for rear live axles. Vanadium is recommended for front axles, steering knuckles, propelling shafts, etc. For sliding gears, nickel-chrome steel hardened throughout, or mild nickel steel case-hardened, are recommended. For crank-shafts, use nickel steel or vanadium steel. For frames, use low carbon open-hearth steel, mild nickel steel or nickel-chrome steel. Open-hearth steel of say 0.4 per cent carbon is recommended for hand levers, tubing, and nearly all other parts of a car.

Superheated Steam on Locomotives. By Mr. H. H. Vaughan.

The author reviews the application of superheaters to locomotives in the United States and illustrates Schmidt's superheater, the type most used in Europe. Mr. Vaughan is assistant to the president of the Canadian Pacific Railway and is responsible for the application of 197 various types of superheaters to the locomotives on that road. The Vaughan-Horsey type of superheater is described, of which 88 are in use on the Canadian Pacific, and of which 175 more are ordered. The paper concludes that the locomotive superheater is worth while. Although there have been troubles from lubrication and leakages, the added capacity of a locomotive and the reduction of the work required of the fireman, to say nothing of the saving of fuel and repairs, make the superheater a boiler feature that considerably decreases the cost of locomotive operation and maintenance.

Special Auto Steel. By Mr. Thomas J. Fay.

The paper is descriptive of the characteristics of high-grade alloy steels that have been developed within the past few years, and which are especially adapted to the severe requirements of automobile construction. The paper is illustrated with photographs showing specimens of bent forgings, chips taken from chrome-nickel steel, etc.

Ball Bearings. By Mr. Henry Hess.

This paper for the most part consists of a *resumé* and translation of Prof. Stribeck's report on his investigations on bearings made at the Central Laboratory for Scientific Investigation at Neubabelsberg near Berlin, Germany. An abstract will be published later.

CUT OUT ON THIS LINE.

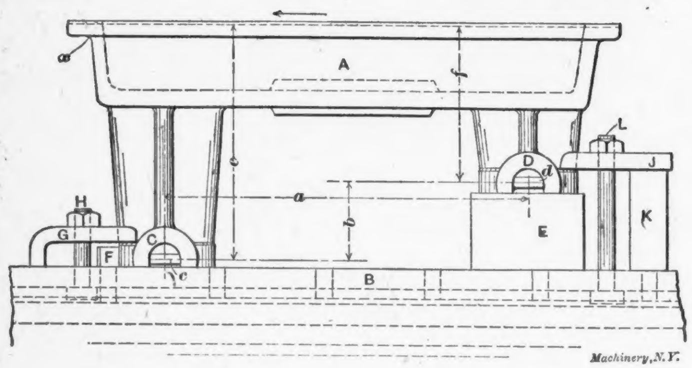
CUT OUT ON THIS LINE.

PUNCH PUNCH PUNCH PUNCH PUNCH PUNCH

These operation sheets, covering every class of shop work, are a feature of all Editions of MACHINERY, and appear every month. They may be cut along the top and margin lines for filing and binding. Suitable binders of sufficient capacity to hold four years' issues will be supplied by THE INDUSTRIAL PRESS, 49-55 Lafayette Street, New York, for 25 cents each, including postage.

SHOP OPERATION SHEET NO. 7.

Oscar E. Perrigo. MACHINERY, July, 1907.



To Plane the Bottom of a Machine Bed Casting.

1. Measure the casting carefully to see if it will finish to drawing. Insert brass pieces *c* and *d* in the shaft spaces; lay off the shaft centers on them with dimensions *a*, *b*, *e* and *f* to drawing, leaving equal finish at all points. If the casting will not finish, reject it and use another.

2. Set casting *A* bottom upwards, resting pedestal *C* on planer table *B*, and pedestal *D* on parallel blocks *E*, which should be high enough to bring the surface to be planed parallel to the planer table. Prove this by measuring with a scale from the planer table to the upper surface at each corner; or with a surface gage, its base resting on the table and its pointer on the upper surface of the work. Use thin sheet metal or steel wedges where necessary, to insure a solid bearing on the table and the parallel blocks.

3. Place pedestal *C* against stop plugs *F* in a direction to take the thrust of the cut. Clamp the work firmly to the table by two clamps *G*, secured by bolts *H*, whose heads enter T-slots in the table. Clamp pedestals *D* on blocks *E* by two clamps *J*, whose rear ends rest on blocks *K* and are secured by bolts *L*. If the work stands up so high as to chatter under the cut, provide stiff bracing from the table to the front end of work at *x*.

4. Test the work again, to see if the upper surface is parallel to the table. If not, slack the bolt at the low point and wedge the work up. Tighten the bolt again and test until found correct, taking care that the casting is not sprung in the process.

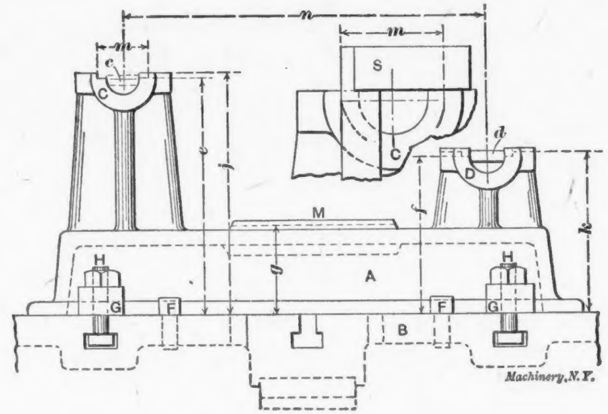
5. With a roughing tool take a roughing cut, leaving about 1-32 inch for a finishing cut; feed from 1-12 to ¼ inch, depending on the size of the casting; the larger the casting the coarser the feed.

6. Replace the roughing tool with a finishing tool, and take a cut down to dimension *e*; feed from ⅛ to ½ inch, according to the size of the casting.

7. Unclamp the casting, and test it with a surface gage. If it is sprung, wedge up, clamp down, and true up planed surface with a finishing tool, taking off as little as possible.

SHOP OPERATION SHEET NO. 8.

Oscar E. Perrigo. MACHINERY, July, 1907.



To Plane the Top Surface and Pedestal Boxes of a Machine Bed Casting.

1. The base of casting *A* is supposed to have been finished, and the centers of the holes have been laid out and prick-punched on brass pieces *c* and *d*, inserted in the shaft spaces. Place the work on planer table *B* as shown, the flange resting against two stop plugs *F*, in a direction to take the thrust of the cut. Fasten the work at the front with clamps *G* and bolts *H*, and likewise at the back side.

2. Chalk the front ends of the bearings in pedestals *C* and *D*. Set a pair of dividers to one-half of dimension *m*. With the prick-punch marks in *c* and *d* as centers, scribe arcs on each side of the center on the chalked faces of pedestals *C* and *D*. Remove the brass pieces *c* and *d*.

3. With a stiff roughing tool in the tool-post, take a roughing cut over the tops of the pedestals and the surface *M*, to within 1-32 inch of the dimensions *g*, *j* and *k*.

4. With a stiff finishing tool, cut down these surfaces to the exact dimensions *g*, *j* and *k*, using a light feed.

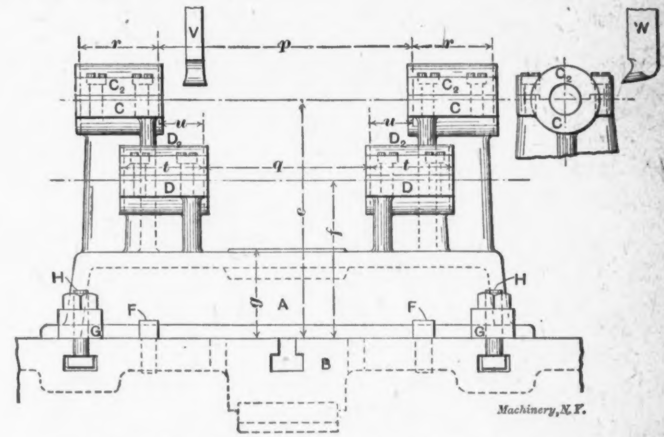
5. With a square *S*, placed as shown in the enlarged partial view, scribe on the chalked faces of the pedestals vertical lines tangent to (touching) the arcs scribed in Step 2. These lines locate dimension *m* for pedestal *D* and the corresponding dimension for pedestal *C*.

6. With a square end tool, cut down the cap seating in pedestals *C* to dimension *e*, determining the width of the cut by the lines scribed in Step 5. Repeat this cut on pedestals *D*, cutting down to dimensions *f*.

NOTE.—Vertical measurements may be made from the planer table with a scale, to a straight-edge laid across the surface being planed; or by the use of a surface gage whose pointer has been set to a scale. Where there is too much stock to be cut away at one roughing cut without undue chattering, two roughing cuts should be taken.

SHOP OPERATION SHEET NO. 9.

Oscar E. Perrigo. MACHINERY, July, 1907.



To Plane the End Surfaces of the Journal Boxes of a Machine Bed Casting.

NOTE.—The journal caps C_2 and D_2 are supposed to have been planed and fitted, drilled in place, the holes counterbored and tapped, and the screws put in place, as shown in the front view and the partial elevation at the right.

1. Place the casting *A* on the planer table, the flange resting against the plugs *F F*, in a direction to take the thrust of the cut. Secure the work at the front with clamps *G* and bolts *H* as shown, and likewise at the back side.

2. Chalk the casting at the necessary points, and lay off the dimensions *r*, *p*, *r*, *u*, and *t*, *q*, *t*, marking them with a scriber.

3. Select a stiff cutting-down tool as shown at *V* and *W*, and set it vertically in the planer head.

4. Beginning at the right, cut down outside of box *C* in two cuts, the second a very light one, and both with rather a fine feed to prevent chattering and springing of the casting.

5. In the same manner cut the inside of the same box, finishing to dimension *r*.

6. Repeat the operation on the inside of opposite box *C*, finishing to dimension *p*.

7. Repeat the operation on the outside of this box, finishing to dimension *r*.

8. Repeat these operations on the boxes in pedestals *C*, observing dimensions *t*, *q*, *t*, except that the first cuts are made on the inside of one of the boxes to the dimension *u*.

NOTE.—The lateral dimensions of a piece of work like this may be laid off by using the cross-rail and heads of the planer as a beam caliper. Use both heads, one clamped in place as the fixed jaw, and the other (carrying a sharp pointed tool or scriber) as the movable jaw. Measurements are laid off by using a scale or inside micrometer caliper between any convenient finished surfaces on the slides. The measurements thus found are transferred step by step to the casting, using the scriber mounted in the tool-post.

A NEW PROCESS OF MAKING WELDLESS CHAINS.

The weldless chain, in the form of the common plumber's or "safety" chain, is a familiar article. It is said to have been devised originally by the inventor of the first watchman's time detector, as the means of fastening the various keys used in the system, scattered at different points about the premises. A chain of this sort can only be "unraveled" from one end, and if that end is sealed with the image and superscription of the owner, the task of deception is a difficult one.

Iron chains of large sizes have been made on the same principle, but more for reasons of strength and ease of making, than for safety. It is a point gained when the weld of the

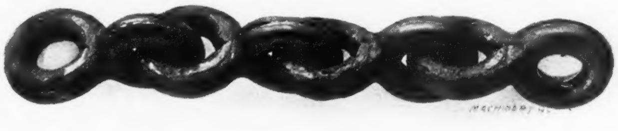


Fig. 1. Weldless Chain, Involving a New Principle of Construction.

ordinary chain link is avoided, since its strength can never be prophesied beforehand, and the whole chain, in the words of the common proverb, is "no stronger than its weakest link." As such chains have hitherto been made, however, it has always been necessary to make the opening in the outer link long enough to admit the next link to be added to the chain. While this elongated link does very well on sheet metal plumber's chain, it is a source of weakness in chains of wrought iron or steel, of large sizes, intended to support great loads. When such a chain passes over a sheave or around a sprocket, the bending stresses set up in the long links quickly deform them and spoil the chain. The object of the invention of an Hungarian, Stefan Kiss v. Ecseghy, by name, is to make it possible to produce chains of this kind with very short, stiff links.

The shape of the chain is shown in Fig. 1. As will be seen, each link is double, being formed of two loops at right angles to each other, one of the loops being split. The method of forming the chain is shown in Fig. 2. The secret of the

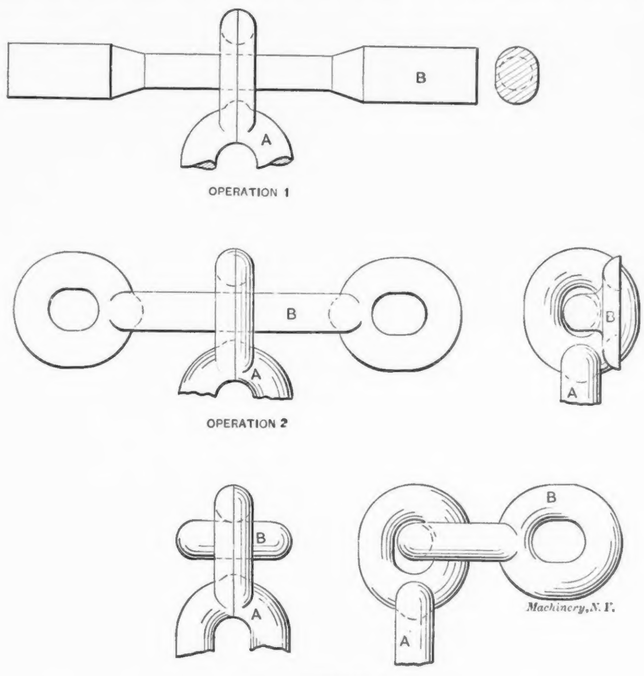


Fig. 2. The Operations followed in Making the Weldless Chain.

process is shown in the first operation. *A* is a completed link, and *B* the blank from which a new link is to be formed. As will be seen, this is made of stock somewhat larger than the size of the chain, reduced in its central portion to that size. These blanks may be made by drop-forging, rolling or any other commercially suitable method. One of them is heated in the forge and inserted in the end of the already completed portion of the chain, as shown. The ends are then struck up under dies to the shape shown in operation 2, where *A* is the end of the finished chain, and *B* the new link being formed. It will be seen that the hole in the old link is but slightly larger than the diameter of the stock composing the new one, while the new half links in the end are of considerably greater size. It would evidently be impossible to insert them if they were formed before insertion, hence the process of inserting the blank first and forming it afterwards. This is the vital principle of the patent. As shown in the third operation, the ends of *B* are next bent around to form the now completed link, which is thus made ready for the insertion of the next blank, as in operation 1.

Fig. 3 shows the machine and dies used for doing this work. The press shown is of a type common in Europe, though seldom, if ever, seen in this country. The two friction wheels on the horizontal driving shaft may either of them be shifted to engage the rim of the heavy balance wheel attached to the vertical screw. The screw raises and lowers the ram of the press. The operator controls the friction wheels by the handle shown, or by the treadle at the base of the machine. A stop

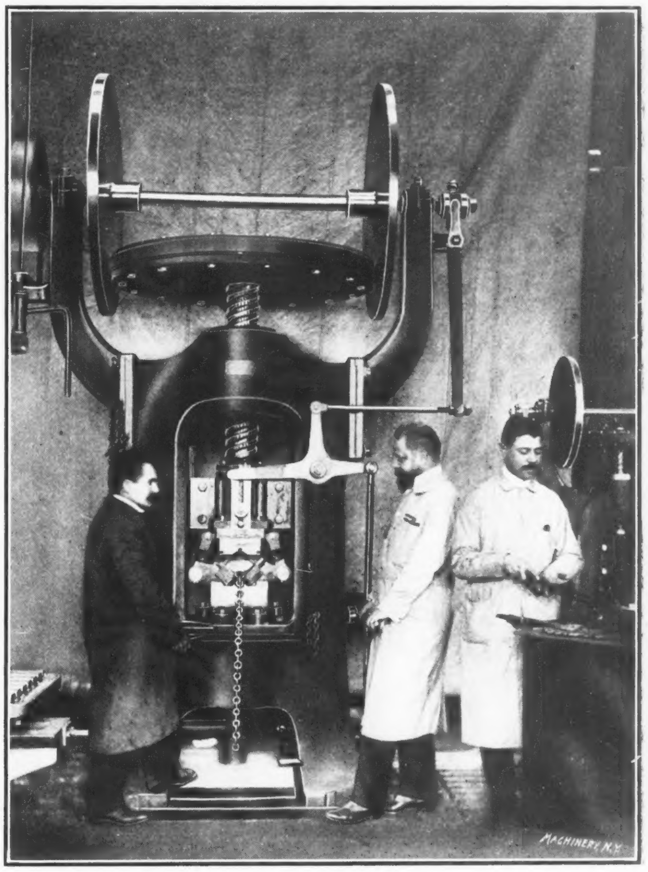


Fig. 3. Press Used in Making the Chain, with the Dies in Place.

on the ram automatically throws out the disk controlling the elevating motion, and stops the ram at the upper limit.

The dies used in this press are shown in Fig. 4. With this arrangement, three operations are necessary for the forming of the completed link, these operations corresponding to those shown in Fig. 2. The completed portion of the chain is suspended over a pulley from the ceiling with the free end in easy reach of the operator of the machine. A heated blank of the shape shown in Fig. 2, operation 1, is taken from the forge, inserted through the link, and placed in dies *C C* on the bed of the press. Ram *D*, shown best in the small detail at the lower left-hand corner, is then brought down on the link, flattening out the ends and curving the central portion. The plunger is raised again, the link is moved forward to dies *E E*, and the plunger is again brought down. The die at *E* is compound, and punch *F* above it, descending on the work, forms the rounded half links on the end of the blank, punches the hole, and trims off the periphery of the work.

The ram of the press is raised for a third time, and the now completely formed (but still open) link is moved to the bending dies at *G G*. When the ram of the press is brought down on the work at this point, after smoothing the work under the

pressing action of punch H, pins J J are pushed in by the operator, entering holes in the links R R, which are then in position to receive them. Of the two parts G, the one at the left in the left-hand view is fastened to a holder integral with ring K, while the other one is supported in a similar manner from ring L. These two rings are free to rock about each other and about the pivot M, formed in the bracket casting N, attached to the bed of the machine. A tie-bar O, keyed to the base P, serves to support the over-hanging pivot M of bracket N. A support not shown in the cut extends out over the finished portion of the chain through which the new link passes, and supports it against the upward pressure of the bending operation, which now takes place. When the ram of the press is started upward, links R attached to it, draw after them die holders Q Q, which rock as described about the axis of pivot M. By this means the link is bent finally into its complete form, as shown in operation 3 of Fig. 2.

machine, where first the central hole was punched through, after which, for a completing operation, the link was pushed through a trimming die to have the fin shaved off. This resulted in an exceedingly neat and clean-looking link with the joint tightly closed and smoothly finished. The operation of forming a link for a half-inch chain takes 25 seconds.

Besides the obvious rapidity of making chains by this method, there is the more important advantage of greatly increased strength. The British government requirements for chains insist on a factor of safety of 5, owing to the unknown quantity of the strength of the weld. A good welded half-inch chain fails at about 13,000 pounds. Samples of this improved weldless type test at about 16,000 pounds when made of wrought iron, and they run with remarkable uniformity at about this load, showing that a higher factor of safety could easily be used. Furthermore, the use of steel is made possible by the fact that a welding heat is not required. A heat intense

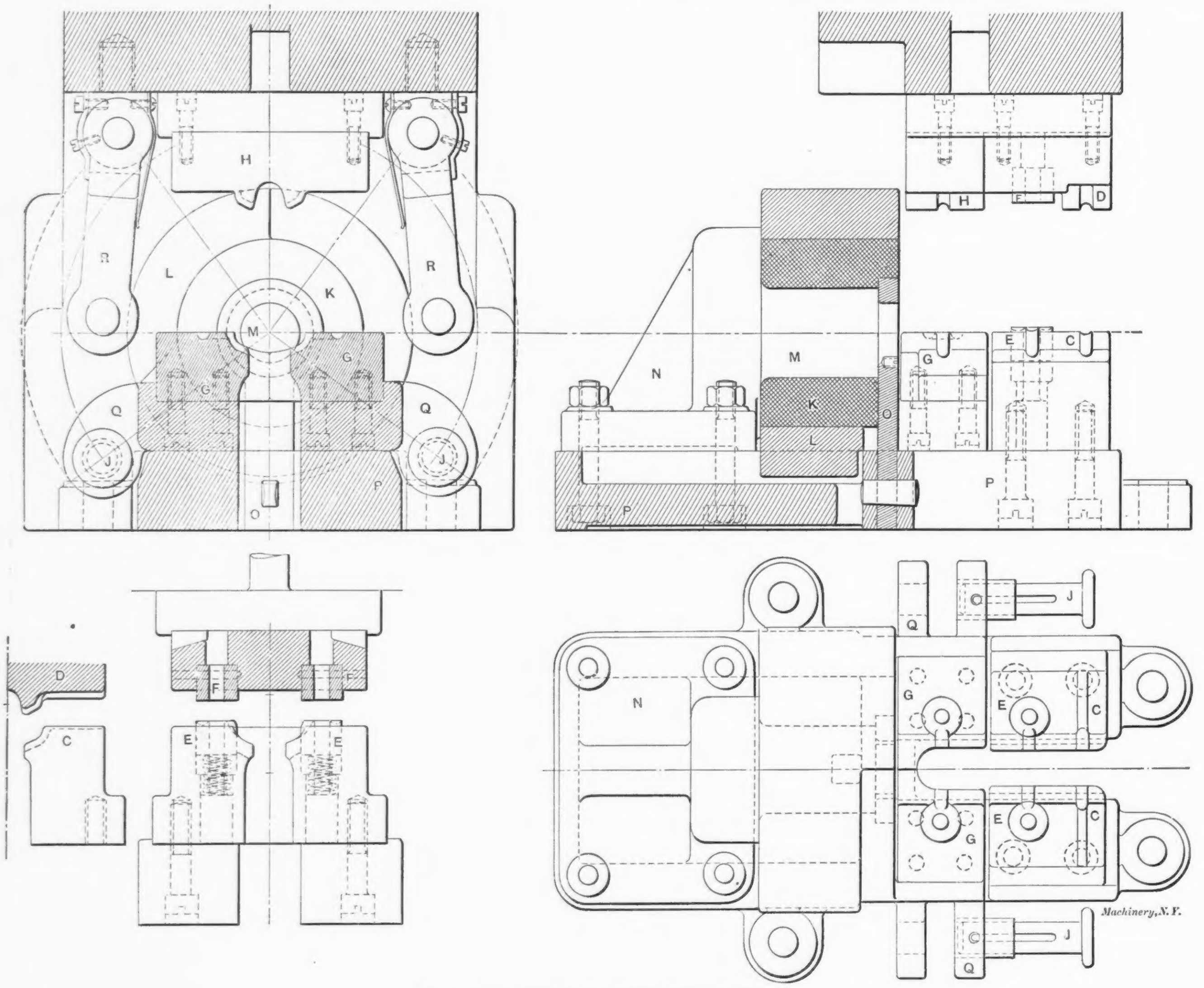


Fig. 4 Tools used in the Press shown in Fig. 3.

The half-tone, Fig. 3, shows three operators. This is not necessary, however, as one of the men there shown is there merely, probably, for the sake of having his picture taken. A boy to tend the fire, and a smith to work the press, is all that is required. The machine is started and stopped by the treadle. The man at the extreme left is the inventor.

The writer has had an opportunity of seeing this process in operation. The tools used were somewhat different from those shown, and more operations were required, although the basic principle involved in the invention was identical. The new link of the chain, which was of half-inch size, was bent in die C as described, but in die E the ends were merely rounded, and the central hole formed nearly through, without being actually punched. The new link was then closed up in a third operation as before. These operations took place in a press of the same type as shown in Fig. 3. The unfinished link was next taken to a small crank press standing beside the larger

enough to weld steel will decarbonize it, so that it has not the strength that it previously possessed. Steel is especially useful in crane service, where durability is fully as important as strength. A wrought iron chain will wear and stretch until it will not fit the sprockets, long before it breaks. Steel chains made by this new process test at about 21,000 pounds for ½-inch size. Fractured samples seen by the writer failed at the sides of the links, and not, as might be expected, at the joint where the two parts of the same link come together. An interesting point was the fact that the two halves of the split link begin to separate a little time before the final rupture takes place, thus serving as a sort of safety indicator to apprise the user of the fact that he is near the danger limit.

This invention is controlled by the Internationale Handelsgesellschaft, Kleinberg & Co., and is for sale in this country by the International Import and Export Co. of No. 1 Madison Ave., New York.

LETTERS UPON PRACTICAL SUBJECTS.

DEVICE FOR LAYING OUT THE CAMS OF A CAM PRESS.

The cams which actuate the cutting or drawing slide of a double acting cam press are different from other cams, inasmuch as each one actuates two rollers which are a certain fixed distance apart from each other. In order to avoid backlash or springing of the connecting-rods, a fault which is to be found in most cam presses, it is evident that the rollers must both touch the face of the cam at all times. In Fig. 1

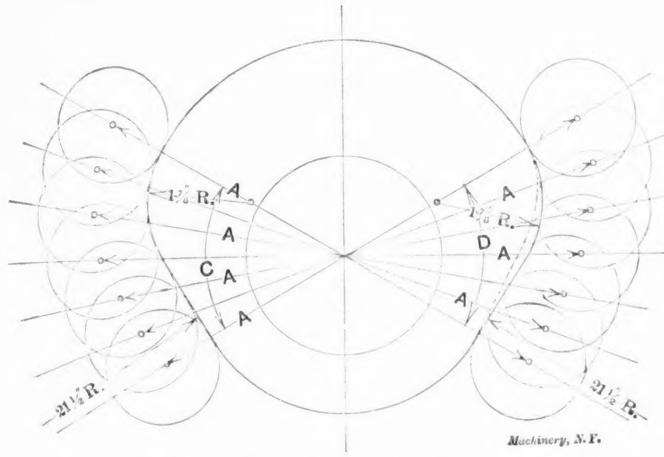


Fig. 1. Ordinary Method of Laying Out Cams.

is shown the ordinary method of laying out such cams; this cut also shows the fact that this ordinary method does not accomplish the end desired. We see that in this cam both curves which give to the slide its up and down motion are constructed with the same radii, which clearly must give a curve that is faulty at certain points. The one main feature that our cam must possess can be expressed as follows: Two rollers of equal diameters, which are a certain fixed distance (*A* in Fig. 1) apart, on a line passing through center of cam, must always tangent the cam while the cam makes its revolution. Turning to Fig. 1., we see that the curve which spans angle *C* and the dotted curve which spans angle *D* accomplish this object. A little reflection will convince that such a curve

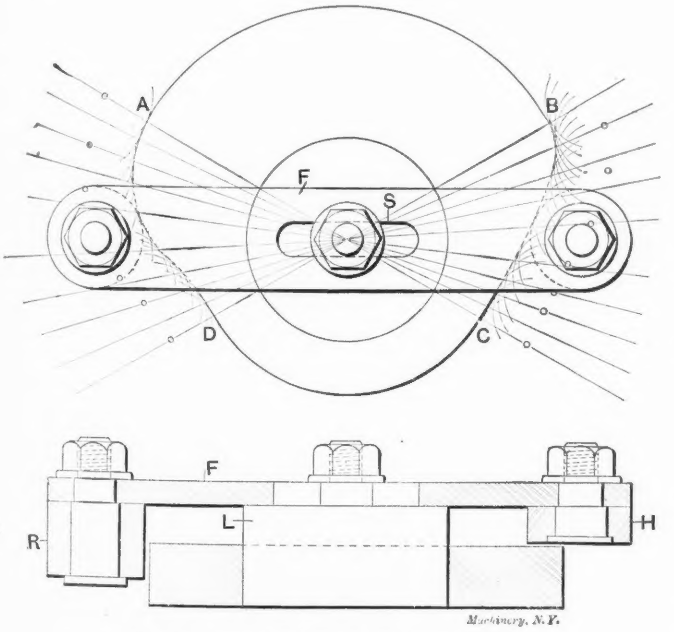


Fig. 2. Device for Laying Out Cams Correctly.

cannot be constructed absolutely correct by giving the radii for both the up stroke and down stroke curve, owing to the fact that the shape of one is entirely dependent on the shape of the other.

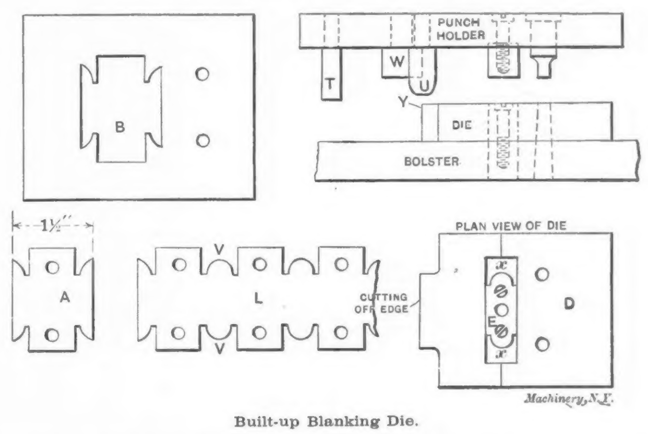
We can, however, give the radii for one curve and construct the other curve from it by aid of the following device. It is assumed that in most cases it will be economical to cut a master-cam, and use this for cutting the others. However, where only a few cams are to be cut, it will be well to construct one with the aid of our device, and use this one as a templet for the others. Fig. 2 shows the device mentioned. First, cut the two arcs, *A B* and *D C*, which of course are perfect circular arcs of given radii, and also cut the curve *A D* from given radii. Then place center plug *L* into center hole of cam and fasten bar *F* onto *L*. Bar *F* has two rollers, *R* and *H*, fastened in such a way that their center distance is equal to the center distance of the cam rollers in the cam press in which the cams are to be used. The rollers *R* and *H* have the same diameter as the cam rollers in the press. We now keep the roller *R* against the cam along the curve *A D* and follow this curve along its entire length. Center plug *L* will always keep the line connecting *R* and *H* in the center of the cam, and slot *S* enables us to follow the curvature of *A D*. By scratching the outline of roller *H* on the cam blank at very short distances apart, we will have a full outline on the cam blank, which must indicate the absolute curvature of *B C*. This curvature must possess all the qualifications set forth above as absolutely indispensable for a correct cam press cam. A cam or set of cams laid out in this manner will silence one of the principal objections usually raised against a cam press: back lash or springing of the cam roller connecting-rods; and practical demonstration has proven the utility of the device shown.

E. E. Eisenwinter.

Providence, R. I.

SECTIONAL BLANKING DIE.

The writer recently had occasion to design a die for cheaply producing the blank shown at *A*. Ordinarily the die is made same as at *B*, involving considerable filing, and causing weak



Built-up Blanking Die.

points on the punch, and weaker ones in the die. The die in question, however, was laid out as shown at *D*, and made in halves to facilitate machining the slot. The part *E* was then made, and securely screwed and doweled to the bolster in its proper position, as shown. Considerable filing on the die, and milling and fitting on punch, was saved by making the die in this way. The chief item in the long run, a great saving of stock, is also afforded. In making the bolster, only the holes *x* were cut through, leaving a center piece on which to screw piece *E*. The stripper is made with a gage side, and a spring slide on the other side, which keeps the stock against the gage side. To produce the blank *A*, the stock is first carefully stripped to exact width. One end is then fed under the stripper until the end reaches the center of opening *x*, when the first cut is taken. This operation cuts out the two openings *V* and also pierces the two holes. The stock is then fed along until the end touches the stop pin *T*, and the treadle can then be held down until the end of the strip is reached. The stop pin does not raise above the face of the die, and therefore it is impossible to "jump" the stop. At each stroke the locating pins *U* enter the slots *V* before the punches touch the stock. This locates the stock, and the punch *W* cuts off the piece at *Y*, completing the blank. On thick stock it would be advisable to back up the punch to

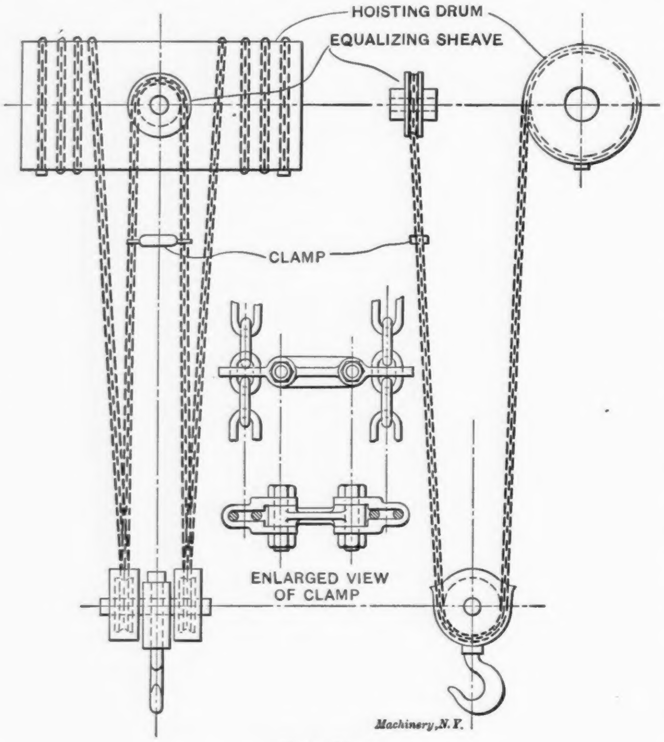
prevent it from springing away on account of cutting only on one edge.

This style of die can be employed on a variety of work where a few thousandths variations are allowable. About the only variation in size that will occur is due to carelessness in cutting stock to exact width. When using a die made as the one shown at *B*, which leaves a margin of scrap stock on all sides of the space blanked, the loss is between 30 to 50 per cent. The saving of the stock when using the die herein described is a big item. At *L* is shown a strip of stock as it would look if the pieces were not cut off. F. E. Shailor.

Great Barrington, Mass.

EQUALIZING CHAIN CLAMP.

A diagram of the hoisting arrangement of a five-ton crane is shown in the accompanying cut. As will be seen, the two ends of the chain are fastened to the hoisting drum and run down through the hook block sheaves, and then up and around



Chain Clamp.

the equalizing sheave located in the frame in line with the drum. By this arrangement the chain can slip forth and back through the equalizer so as to keep the strain distributed equally on all the four strands of the chain. There was, however, when the crane first was put in place, no provision to keep the chain from getting twisted, and even when the best crane chain was used, it got twisted and would suddenly bind in the hook block, throwing the entire strain on one strand of the chain with the result that the chain would break, causing delay and loss. In order to remedy this and reduce the constant loss from breakage as much as possible, the clamp shown in the cut in enlarged scale was made and put on the chain at the place shown. When put on, the links were turned right from the drum down through the hook blocks and up to about three feet below the equalizer, where the clamp was fastened. This clamp has proven an effective means for preventing the chain from getting twisted. It was the usual thing that we had a broken chain every week or two, while since putting on the clamp we have not had a break for nearly two months.

Valley Park, Mo. W. O. Renkin.

ADVANTAGES OF STEADY WORKING.

When I was coming home in the car the other night two men sat in front of me discussing the question of more pay; or, rather, they were not discussing it, for they argued that it was impossible to get wages raised as they ought to be. While they were talking, a third man came along and sat opposite them. He was a man whom I know as a shop superintendent, who has risen very rapidly of late years from the ranks, through the grades of gang boss, foreman, salesman, and draftsman, to his present position as superintendent. They repeated, for his benefit, the tale of woe that I had previously overheard. He laughed at them, and then told his story. What he said, I believe he meant, and it seems to me as if it might well be repeated.

"Now, look here, fellows," he said, "you and I worked over at Jones's eight years ago at the scratcher's bench, and I know just as well as if you told me that you have said a thousand times since, when you looked my way, 'A fool for luck.' But I don't see a bit of luck about it. It was hard work there at Jones's, and you fellows laid back when the boss was out of sight and laughed at me for keeping my hammer going. One day the old man lost the man on the chucking lathe, and he sent me up there to fill in until he could get another. Why did he pick me instead of you? Simply because I was there when he came down, and you two chaps were soldiering down in the wash-room. Why did I stick on the chucking lathe? Because I had kept an eye out for what was going on all around the shop, in hopes that when I got a show, I would make good. Then you men laughed at me for not kicking for more pay as quick as I knew I could stay on the machine. But I did not; not then; not until Tom went over to Atkin's shop to work. Atkins asked Tom where he could get a hand to run that old pulley lathe, and Tom told him I could do it. Atkins offered me just the same pay I was getting to go over there and be a machinist. I told the old man about it, and he told me that if I wanted to be a machinist, I should stay right where I was. I suggested that money would talk loud enough for me to hear it, and he raised me a quarter on the spot. And that has been the way ever since. Instead of getting sore and laying back and killing time, I have worked faithfully and steadily, and somehow or other people have heard of it and have invited me to come and work for them. Two or three times I have accepted the offers, but after a time I drifted back home. Now you needn't make up a face and say that no one ever sees you when you are working. They hear of you. Every foreman in the city is looking for men that can do good work and do it quick, and if your heads stood up just a bit above the level of that crowd that you associate with, you would have a better job, even if they had to kidnap you to get you——"

They got off the car there, and I stayed on, but I had heard enough to make me feel that if I had stuck to business better, and kept an eye out for better chances, perhaps I, too, would be better fixed than I am now. Cox Wise.

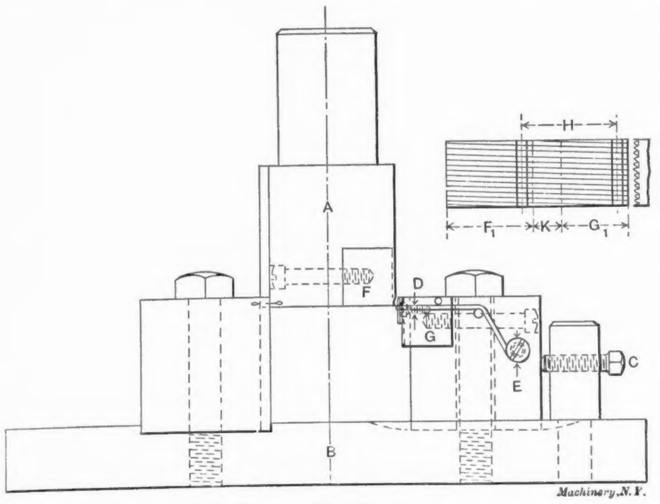
THREAD-ROLLING DIES FOR SMALL INTERCHANGEABLE SCREWS.

Stacy Oliver.*

The accompanying illustration shows a thread-rolling device as applied to a punch press. *A* is a punch holder to fit the punch press. *B* is the bolster, or a piece of cast iron about 1 inch thick, upon which are located two cast iron blocks, one made stationary and the other adjustable by slotting *B*, so that the block can be forced ahead by the setscrew *C*. There is a groove in the stationary block and a tongue in the punch holder *A* to prevent the dies from getting out of line. The screw *D* is for holding a thin piece of steel as a stop so that the thread can be cut to the desired length. The screw *E* holds a wire supporting the piece to be threaded until the upper die, *F*, comes down and carries it past the lower die, *G*. In cutting the die, it may be made in one piece, *H* being the

* Stacy Oliver was born in Farmington, Maine, in 1876. He served an apprenticeship in the shops of the Manufacturing Investment Co., Madison, Maine. Among other shops, Mr. Oliver has been working at the Bath Iron Works, Bath, Maine; American Optical Co., Southbridge, Mass.; Stanley Instrument Co., Great Barrington, Mass.; and the Remington Typewriter Co., Ilion, N. Y. He has been employed as machinist, toolmaker, foreman and designer. His specialty is small interchangeable work and the design and making of tools for this class of manufacture.

circumference of the thread to be rolled and G_1 the desired length for the lower die. F_1 is the desired length for the upper die, which must be longer than the lower die so that it will roll the wire past the die G and permit it to drop out of the way. The part K must be cut out when cutting in two parts. The proper angle to which to cut the die depends on the pitch of the thread. The pitch divided by the circumference of the



Thread-rolling Device.

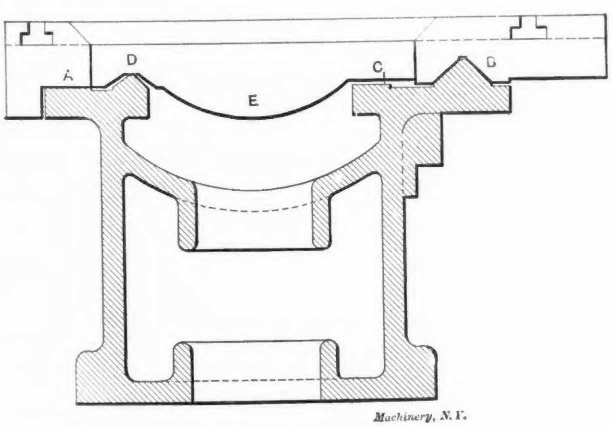
screw to be rolled will give the tangent of the angle. In cutting the die, which must be of good tool steel and hardened after making, the shaper is used. The cut is taken with a tool that can be taken off and put back again without changing its location, such a tool, for instance, as a circular threading tool. In case the point should happen to get dull, the tool can then be removed for grinding. If the feed screw has not got the desired graduations on it, a brass index plate can be made very quickly, and used on the machine. The brass plate should be of a good size and cut accurately in a milling machine, and a pointer clamped on the shaper. S. OLIVER.

Great Barrington, Mass.

SUPPORTING THE LATHE CARRIAGE AT A WEAK POINT.

The accompanying drawing shows a sectional view of the bed of a lathe designed at Michigan Agricultural College. The carriage, with apron removed, is seen resting upon the ways. The bed is of the box form, with openings for the chips to drop through. As will be seen, the carriage slides upon one flat way at A, and on a large V at B. The tail-stock is carried by a flat way at C and one V at D.

As lathe carriages are commonly constructed the bridge or cross-beam is left rough at D, and as the rough casting must



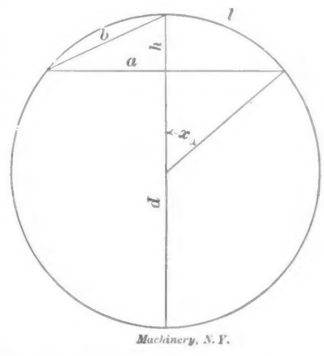
Supporting the Lathe Carriage at a Weak Point.

have ample clearance, the carriage is weakened at this point. One large machine tool company lowers the V in order to avoid the weakness referred to, and this concern holds a patent on a lathe bed having a "drop-V" for the purpose stated. This circumstance is mentioned to show that the matter is considered as of some importance. In the endeavor to get the same result without infringing a patent, the carriage here illustrated was made wider at the bridge than is commonly done, and was machined at D in such a manner that a slight deflection would cause it to touch the V at this point. This plan is not as good as dropping the V, and doubtless some mechanics will think it is altogether wrong to have a bearing at D. It is somewhat difficult to justify the design, but the idea was to have the carriage scraped to a bearing at both A and D, and then slightly relieved at the latter place. When thus fitted, the carriage touches at D when this support is most needed, *viz.*, when under considerable pressure. It is assumed that the pressure would never be sufficiently great to so deflect the carriage at E as to cause it to lift at A.

Atlanta, Ga. W. S. LEONARD.

DIAMETER FROM ARC AND MIDDLE ORDINATE.

In the May, 1907, issue of MACHINERY some formulas were published which I derived at the request of Mr. J. J. Clark, and which were communicated by him to the editor. A brief statement of the method, by which these formulas were obtained, may be of interest.



Diameter from Arc and Middle Ordinate.

Huygens's familiar expression for the approximate length of arc is:

$$l = \frac{8b - a}{3},$$

in which

l = length of arc,

a = length of chord of whole arc,

b = length of chord of half the arc.

Denoting the diameter by d, and the middle ordinate by h, we have, from geometry,

$$a = 2\sqrt{(d-h)\,h}\,;\quad b = \sqrt{d\,h},$$

and Huygens's formula becomes:

$$l = \frac{2\,(4\sqrt{d\,h} - \sqrt{(d-h)\,h})}{3} = \frac{2\sqrt{h}\,(4\sqrt{d} - \sqrt{d-h})}{3}$$

Solving this equation for d, the first of the three formulas communicated by Mr. Clark is obtained. The other two are derived from this by developing the radical and transforming.

When tables are available, the shortest way to solve this problem is as follows: Let $2x$ be the central angle, expressed in radians, corresponding to the arc l. Then,

$$l = d\,x;\ d = \frac{l}{x}.$$

Also,

$$h = \frac{d}{2}\,(1 - \cos x) = \frac{l}{2\,x}\,(1 - \cos x),$$

whence,

$$x + \frac{l}{2\,h}\cos x = \frac{l}{2\,h},$$

or, writing c for $\frac{l}{2\,h}$,

$$x + c\cos x = c.$$

This equation can be very readily solved by trial. The value of x, in radians, is simply the length of the arc, in a circle with a radius = 1, corresponding to the value of x in degrees. Values of x, both in degrees and in radians, can be taken from a table giving lengths of arcs to a radius = 1; the value in radians is substituted in the formula, and the value in degrees is used for computing $\cos x$. If a table of natural versed sines is at hand, the equation may be put in the more convenient form:

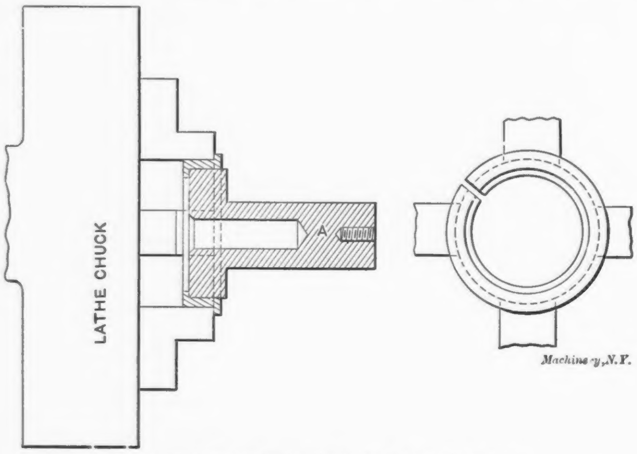
$$x = c \text{ vers } x.$$

I should like to remark, parenthetically, that the practise of using the term "versed sine" to denote the middle ordinate is both obsolete and misleading. The versed sine of an arc or angle is 1 minus the cosine; being a ratio, it is an abstract number, not a linear quantity. ANTONIO LLANO.

Scranton, Pa.

SPLIT BUSHING FOR HOLDING WORK IN LATHE CHUCK.

The cut herewith shows a very useful device for use in a lathe chuck, which I call a chucking ring. It is made of machine steel and is used to hold pieces of 2 inch bar brass, 3 inches long, which are to be turned up as shown at *A*. The bars are too large to be run through the hollow spindle of any lathe in the shop, otherwise the pieces could be turned from the bar. As this is not possible, I cut off all the pieces just long enough to finish to the required length, and then use the ring to hold them during the operation as shown in the cut. The chuck used is a four-jawed independent chuck. The advantages of using this ring are that it holds the work securely, without marring the end, which is left the full size of the bar, and after the first piece is made to run true, by opening and closing the same two jaws each time a piece is removed and another put in its place. I find that they will



Split Bushing for Holding Work in Lathe Chuck.

all come nearly central, without causing much bother of truing up each time. After the first operation has been completed on all the pieces, they are faced and drilled, using a 6-inch universal chuck to hold the piece during the second operation. I have a number of rings of the description above for various jobs that come along. R. B. Casey.

Schenectady, N. Y.

HYDRAULIC STOP COCK AND UNION.

In our factory we use a good many hydraulic cylinders working under about five hundred pounds pressure per square inch, and as the work, while not hard, is continuous, and the cylinders as well as the valves and fittings get very little attention, we have found it practically impossible to keep any of the standard makes of valves or unions from leaking for

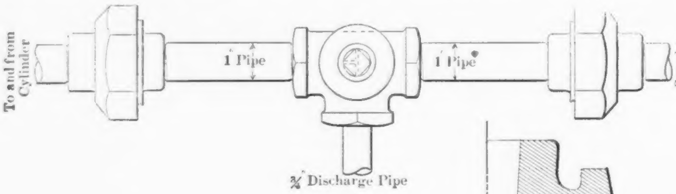


Fig. 1. Hydraulic Stop Cock.

any length of time. We therefore finally designed the three-way stop cock shown in Fig. 1. At first we made both the body and plug from brass, which we found unsatisfactory, owing to the plug cutting out around the opening. We then made some with soft steel plugs, drilled as shown, which have given entire satisfaction. Although these stop cocks are very much heavier than any on the market, yet one of these costs less than two standard two-way cocks, or one standard three-way cock, and will last much longer, as we have had some of them in use for nine weeks, and they do not show any wear or leak, while it was steady work for one man making changes and repairs before.

It will be noticed in the cut that there is a union above and below the stop cock, this being necessary so as to make quick changes or repairs, stop cocks complete with nipples

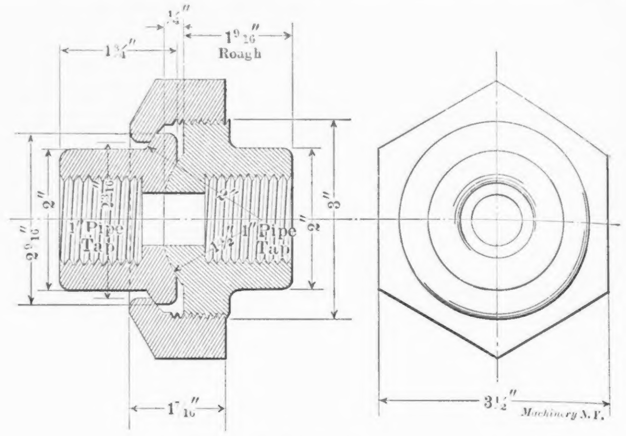


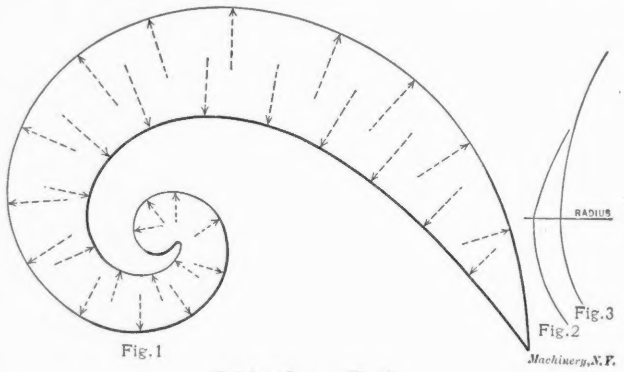
Fig. 2. Hydraulic Union.

and male parts of unions being always kept ready by the pipe-fitters. The standard union was found unsatisfactory owing to tendency to leak, and the supply pipe easily got out of line, so we had unions made, as shown in Fig. 2, which also are very heavy and are in the form of a ball joint which allows for shifting of pipes, and allows the union to be tight without using any gasket at all. These unions have given good satisfaction and are even cheaper in first cost than the standard hydraulic unions at present on the market, as they actually cost but \$2.50 each, while the standard ones cost us \$2.65 each, and these new ones are lasting much longer.

Valley Park, Mo. W. O. Renkin.

JOINING CURVES NEATLY.

There is only one condition under which the end of a curve can be joined neatly to another curve, or to a straight line, so that the two lines shall flow neatly together—and that is



Joining Curves Neatly.

where both the lines are tangent to the same radius at the point of meeting. In any other case there will be a break or sharp place which will be very apparent to the eye; and further, a piece made after the drawing will not be so strong as though the curve flowed regularly. The difference in strength may be hardly calculable, but is there, all the same, and the appearance will always be better where this rule is followed.

There is a very simple way to attain this desired end, and that is to draw at various points on the wooden or other templets, which are used for making simple or compound non-circular curves, radii (or in the case of concave curves, prolongations of radii) to the curve, that is, lines at right angles to the curves at the points chosen.

Fig. 1 shows a logarithmic spiral templet with such radii and prolonged radii marked thereon; Fig. 2, a compound curve drawn therewith without reference to the rule, and Fig. 3, one properly drawn. Robert Grimshaw.

Hanover, Germany.

EFFECT OF CHANGING LOCATION OF CAM ROLLER.

When the line of motion of a follower passes through the center of rotation of the cam, and the angle of the curve causes it to work hard, the curve may be modified, and the same motion of follower obtained by placing the follower with its line of action parallel to its original position and not passing through the center of the cam. A condition may be assumed, as shown in Fig. 1.

Here we have a cam, rotating in the direction indicated by the arrow *A*, whose duty it is to move the follower ¾ inch in the direction indicated by the arrow *B* during a 30-degree angle of motion of the camshaft. The angle of the cam as

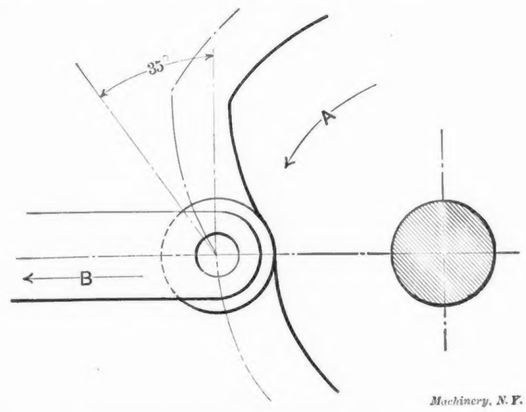


Fig. 1. Cam Roller on Center Line of Cam.

presented to the follower at the beginning of the stroke would be 35 degrees, as determined by the tangent to the curve of the centers, as indicated on the drawing. After the follower had moved one-third of its distance, the angle presented would be 32 degrees, and when two-thirds of the travel had been made, the angle of the curve would be about 30 degrees. The angles given are for a curve which would give a uniform motion to the follower. Should the cam curve work hard at the required speed we would naturally make the cam of greater diameter, if possible, which would reduce the angle of the cam, as shown by the difference in the angles presented in Fig. 1, as we go out from the center of rotation. The design of machine, however, might make

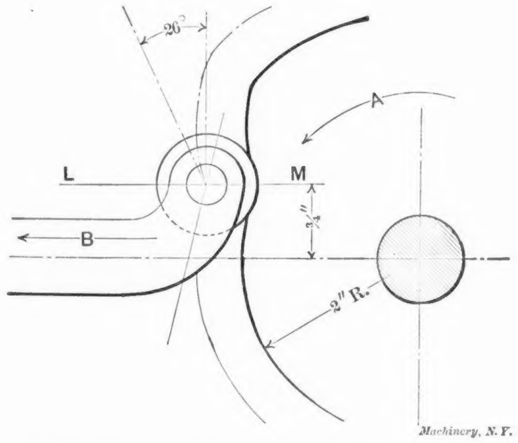


Fig. 2. Cam Roller placed above Center Line of Cam.

this change impossible. If it was simply necessary to get the follower from the position shown to a point ¾ inch distant in a 30-degree movement of the camshaft, without regard to its motion, a harmonic or gravity curve might be used which would cause the cam to work easier. However, this would be impossible should our design require a uniform, or some other equally hard motion. A third way in which the angle of the curve might be decreased would be to make the angle of motion of the camshaft greater. This, too, might be made impossible by the limitations of our design.

Another way, and one not commonly used, is suggested in the opening paragraph of this article. In Fig. 2 all conditions are the same as in Fig. 1, except the roller has been placed ¾ inch above the line passing through the center of the cam. The center of the roller will now pass along the line *L M*, or parallel to the line of motion in Fig. 1. The angle of the curve presented to the roller in this case is 26 degrees, much less than the angle presented in Fig. 1, and the angle decreases as the roller moves away from the center of rotation. The advantage that may be gained by moving the cam roller may be readily seen by comparing the results given above. There is, of course, a limit to the distance the roller may be changed, for if placed too far away from the center line, the thrust in the direction at right angles to the direction of motion of the follower would be so great as to offset the advantage gained.

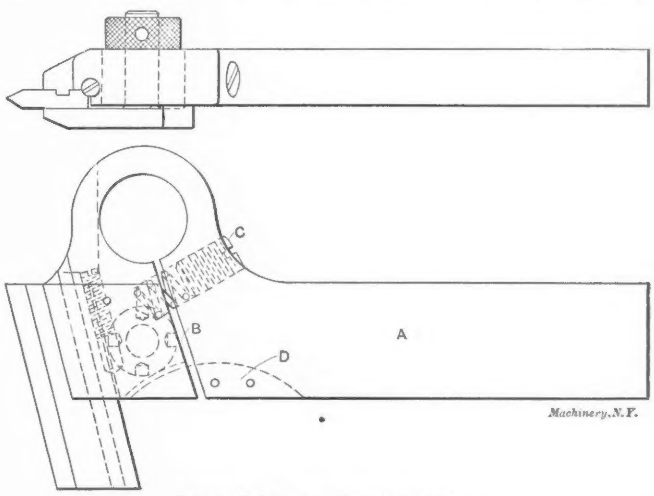
Without the aid of an illustration I think it may be seen that to place the cam roller on the other side of the center would cause the angle of the cam curve to increase, thus making conditions worse. The offset of the roller should be in the direction opposed to the direction of motion of the cam.

ARTHUR B. BABBITT.

Hartford, Conn.

SPRING HOLDER FOR THREADING TOOLS.

In a large shop in the West, in which I was employed, a number of special thread-cutting tools, such as shown in the accompanying cut, were used. These tool-holders were intended for the blades or single-point cutters made by the Pratt & Whitney Co. The improvement in the design consisted in the provision for permitting the tool to spring away



Spring Holder for Threading Tools.

from the work if too heavy a cut was taken. In other respects the principle of the holder was the same as that of the one manufactured by the Pratt & Whitney Co., itself, for these tools. Referring to the cut, *A* is the body, which is slotted at *B*, proper resistance being given the tool by the setscrew *C* which has a spring at the lower end, acting upon the front part of the holder. The part *D* is an inserted blade or key, which keeps the front part of the holder from bending to one side while cutting. This tool proved to be most popular in the shop. The preference was given to it not on account of its novelty, but because more satisfactory results were obtained than with the ordinary tool-holder.

JIM.

[A great many designs of spring tool-holders have been tried, and the one shown in the cut is comparatively common. The difficulty with holders of this kind is that it is almost impossible to adjust the screw for each particular pitch to be threaded so that the spring has the proper tension. It is evident that in cutting a coarse thread there is no need of the tool being as sensitive as when cutting a very fine thread, but there is no means for judging when in each particular case the proper springing action has been attained. Another objection to the design shown above is that it prevents a full and clear view of the thread being cut, the projecting part extending partly above the work. Of all spring thread-tool holders hitherto designed, however, this one is about as good as any. A spring tool-holder for threading tools which will overcome the objections mentioned is greatly in demand, and many attempts have been made to solve the problem, but as far as we know none has been entirely successful.—EDITOR.]

FIXTURE FOR SLOTTING ROD BRASSES.

I noticed in the January issue a description of a jig for slotting or planing connecting rod brasses. The author says, "Of course this jig can be improved upon," and for locomotive brasses, which are generally planed perfectly square in most shops, I think the one shown herewith to be an improvement, inasmuch as it is much easier made and also

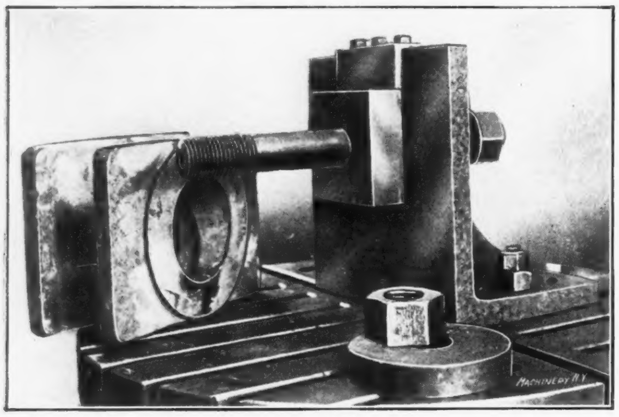


Fig. 1. Fixture for Slotting Rod Brasses.

easier to keep it in good condition. The piece *B* of his jig is rather a difficult piece of work, and the constant wear on the bushes will, I am sure, make it difficult to keep it in such condition that it could at all times be depended upon to turn out a perfectly square job. This piece *B* on the jig as shown in Fig. 3 has been milled square, and when one side of the brass has been machined, the nut behind the angle plate *A* is loosened and the sliding bar pulled forward sufficiently to clear the angle piece or stop *D*, revolved one quarter turn, and slid back under angle stop *D* again. Angle block *D*, of course, must be made to fit snugly down upon the square part of *B*. The two halftones, Figs. 2 and 3, show the jig plainly when used on a machine. OBSERVER.

WHY A MACHINIST WANTS MORE LEISURE.

Mr. Plaisted and his best girl must have had a disagreement to occasion the article which he wrote in the March issue. It is not so long since the writer was in the same position; that is, he was a "greasy mechanic," and had a "best

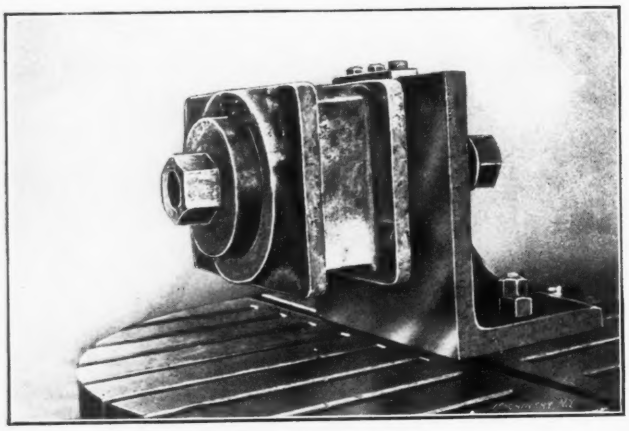


Fig. 2. Work Mounted in Place.

girl," and he can remember about how it seemed. As I recollect it, my best girl did not object so much to the dirt I worked in as to the fact that my work did not give me time enough to spend with her. Part of this was due to the long hours, the time it took to wash up at night, and the fact that I had to get around so early in the morning that, if I wanted to earn my wages, I had to go home before midnight. After she passed the best girl stage, she began to think that I cared too much for the shop. I often had some problem to figure out at home evenings, and there was something that I had to go down Sundays to see to, but it never was the dirt that troubled her; it was just time—and the fact that we could not talk together about my work. To be sure, I told her all about the heads and carriages and saddles and aprons on our tools, but that was not half so satisfying as the colored silks and cloths that one of her other best fellows used to sell. To be sure we had more money to spend than Mr. Drygoods would have had, but what was the good of having the money if I was too tired and pre-occupied to enjoy it with her. Mr. Drygoods had an afternoon off every week and never thought of working a minute on Sunday.

Now what I make of all this is that machinists have been at work all these years building labor-saving machinery to the end that others than themselves might have leisure. A machinist to-day is as steadily at work and longer at work than almost anyone else. What he needs, and what his best girl and better half wants him to have, is more time at home. You give the average machinist the choice of 10 per cent more pay or 10 per cent fewer hours at the old pay, and he will speak for the money quickly, but in a week "she" will have talked him out of it, and he will, if he dares, ask for that 10 per cent reduction of time. And then he will find that it is not merely that he wants to work less, but that he wants more time in a lump. Drop off an hour a day and see how long it will be before your workmen are around to lump it all on Saturday. They do not object to the work, but every one of those men has somewhere a spark of love for his family, and for the woods and fields, that prompts him, as soon as he gets above the point where he is not hungry or cold, to wish for time for himself more than for money.

Now I hope no one will think that because my best girl doesn't like to have me thinking about the shop when I am at

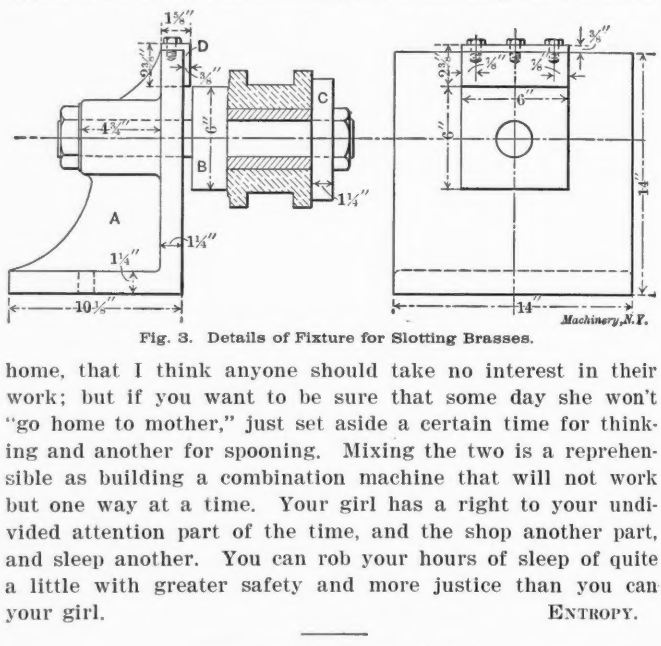


Fig. 3. Details of Fixture for Slotting Brasses.

home, that I think anyone should take no interest in their work; but if you want to be sure that some day she won't "go home to mother," just set aside a certain time for thinking and another for spooning. Mixing the two is a reprehensible as building a combination machine that will not work but one way at a time. Your girl has a right to your undivided attention part of the time, and the shop another part, and sleep another. You can rob your hours of sleep of quite a little with greater safety and more justice than you can your girl. ENTROPY.

THE JARNO TAPER.

I note in your issue of June a table of Jarno tapers. It seems too bad that any one should so far forget the pith and underlying simplicity of the Jarno taper as to give a table in this manner. It is misleading, and inexperienced young men who are readers of MACHINERY are likely to lose all that the Jarno taper stands for when they look at a table made up in this way. It would seem to the writer absolutely unnecessary to prepare such a table and to give it such a mathematical appearance, entirely giving up the fundamental idea, which is its simplicity and the absence of all formulas.

This taper was invented by Mr. Oscar J. Beale, Providence. R. I., and in justice to him and your readers it should be given in exactly the same way that Mr. Beale gave it; that is, a No. 2 taper is 2/8 inch at the large end, 2/10 inch at the small end and 2 halves long. A No. 10 taper is 10/8 inch at the large end; 10/10 inch at the small end, and 10 halves long. Such a proposition as this requires no letters, no signs, no minuses, no pluses, no symbols. It is simplicity itself, and it would seem that any one writing in these practical days for a paper like yours, which stands for the practical shop workman, should not overlook the underlying facts. As for the taper the simple statement that it is always 6/10 inch to the foot is

sufficient. One word more is not only unnecessary, but confusing.

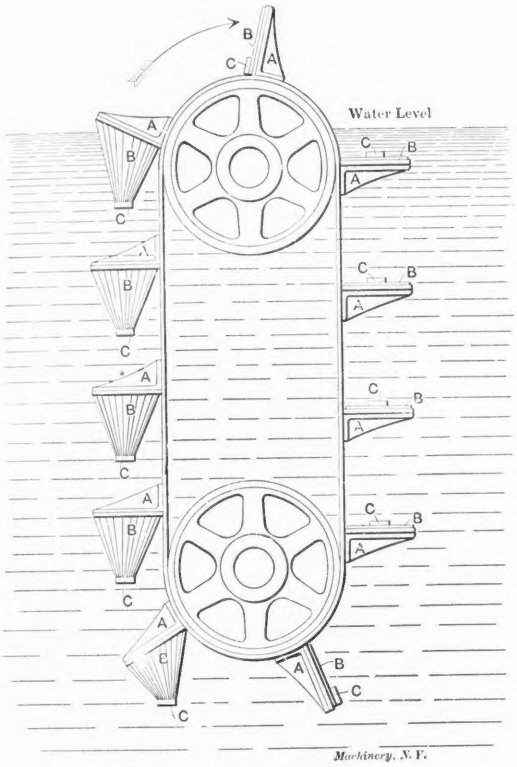
C. H. NORTON.

Worcester, Mass.

[From one point of view Mr. Norton's objections may be valid, but there seems to be really no very good reason why all such shop data, no matter how simple, should not be tabulated so as to save calculation or to check calculations. We all know the difficulty that some men experience in doing even simple addition without errors.—EDITOR.]

R. S. INVENTS A DEVICE FOR PERPETUAL MOTION.

It has seemed rather cruel to me that all my attempts at startling mathematical discoveries have been refuted by the readers of MACHINERY, and that I have not received much gratification out of the labors I have laid down on the altar of science, but it is gratifying to know that all great men have been misunderstood. My disproval of Euclid became a mournful fiasco, and my venture in algebra turned out nearly as bad. Finally, my laudable endeavor to solve a problem, which requires mathematics of a higher order, by elementary means, has been classified as ridiculous. But all this probably depends upon that I am more of a practical man than a scientist, and for this reason I have turned my interest toward the field of invention rather than that of science. Even if the present generation does not appreciate my discovery, I am sure that future generations will, and I can well imagine how, in a not distant age, huge machines, generating power by means of my perpetual motion, will be utilized for driving all the machinery in the world. All the expense for generating power will then be that of the first cost and repairs, and these expenses will be extremely small on account of the simplicity of the device itself. If I continue to invent as wonderful things as I have done heretofore, it may be that I will be able to overcome even the initial expense.



R. S. Epoch-making Perpetual Motion Device.

In fact, I have invented nothing more nor less than a perpetual motion power generator. The crude principle of this is shown in the accompanying cut. It is so simple, indeed, and so certain in its action, that I am sorry I have not been able to think of anything in connection with it that could be called a "secret process." That is what troubles me. For, as we all know, no invention is worth much except one embodying some well-known "secret process." To return to the perpetual motion, however, it consists of two pulleys on shafts resting on ball bearings. On the pulleys a belt is running, and on this belt several brackets *A* are fastened. To these brackets are fastened rubber or impregnated cloth bags *B*, to which are in turn attached weights *C*, preferably made of lead. The device is sunk into water as shown, and moves as indicated by the arrow. It is evident that when the brackets are on the right-hand side of the device, moving down, the weight *C* falls and rests upon the bracket *A*, and the bag *B*, out of which the air has been pumped, and which thereafter has been hermetically sealed, is compressed. When the brackets have come to the lower end of their travel, ready to move up on the left-hand side, the lead weight pulls down the bag, thereby causing a greater displacement of water and consequently giving to this side a greater tendency to rise than that possessed by the right-hand side. The result is that the device will move constantly in the direction of the arrow.

This scheme is undoubtedly the most perfect solution of the power problem ever attempted. I am just forming a company to start to build this apparatus, and ten years from now I expect to see a great water tank in every factory with one of *R. S. perpetual motion power generators* immersed. Anybody having money to spare may put it in the stock of my company, and depend on the same returns as from ordinary gold-mining stock.

R. S.

WHAT IS A MACHINE DESIGNER?

Whether R. E. F., in getting after Entropy in your May issue, really scores his own point, or whether he helped Entropy make his point, is an open question. If I should say that I objected to having drawings for a machine, made by the office boy and proportioned by set formulas, classed as designs, perhaps my position would be better defined. In the world's history there have always been pioneers, men who went on ahead and blazed the way for civilization, roughed it, and broke down the barriers of nature. Then there have followed the army of workers who have smoothed out the rough places and laid out towns and villages and prepared the way for the tenderer and possibly more effeminate ranks of mankind, who have brought the luxuries and refinement of the extreme of civilization. None of these men wished to exchange places with any of the others. The pioneer would no more sit in the parlor of the society man, if he were allowed, than the society man would go out and rough it on the advance line of progress. Just so it is with designers and engineers. The man who has it in him to ride rough-shod over precedent and attack new problems with his hands unfettered by knowledge of what cannot be done, is not the same man that can take a machine already designed, and smooth out its inaccuracies and reduce it to a manufacturable article, nor is he the same man that can design the jigs and special tools that will make it a profitable machine to build. Now, to my mind, neither of these latter men should be classed as designers. Their work is necessary, but it is not (usually) original. To be sure, many kinks and arrangements of jigs are new, but they are not to be compared with the original bold conception of a machine. I had in mind, when writing my original article, perhaps more than anything else, what the word designing means to technical students. In every school of this kind there is a course in machine design, and there are innumerable books on machine design, but there is almost no machine design taught, and there is almost no machine design in the books. What is taught is the smoothing-off process by which the machines which have already been designed, perhaps by the instructor, perhaps by someone else, are brought down to a basis to which a little theory and some precedent may apply, but of real design these chaps know nothing, and they probably will continue to know nothing when they graduate, till R. E. F. and Entropy both are gray and feeble. These boys will tell you that they have studied machine design and can design machines, but they will have to see one like it before they can begin. Now all that I ask is that the man who can start out with nothing tangible and produce a machine that will work be called a designer, and that the man who turns a crank and drops a formula in the hopper be called something else, I don't care what.

ENTROPY.

SHOP KINKS.

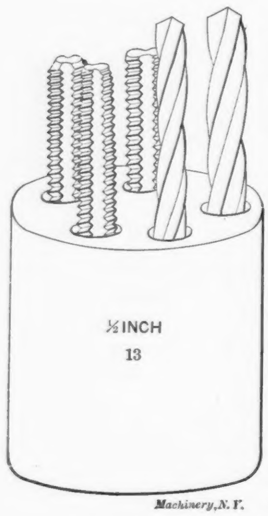
A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

TOOL FOR APPLYING COPPERIZING SOLUTION.

Take a piece of small glass tubing and draw a wire through it, bending the wire so that a tuft of cotton or wool can be placed in the loop. When the cotton becomes soiled, it can be readily substituted by a clean piece. The glass protects the fingers. H. A. S.

HOLDER FOR SETS OF TAPS AND TAP DRILLS.

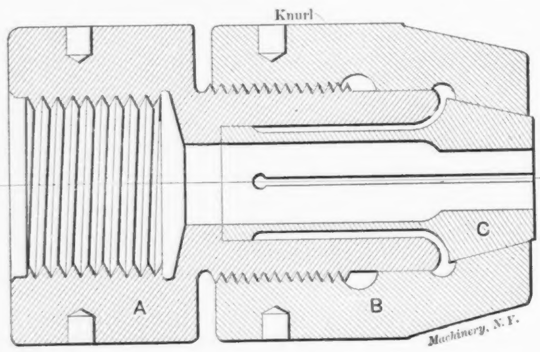


In the cut herewith is shown a convenient means for keeping sets of three taps with the tap and body size drills. The holder for the taps and drills is made from maple or any other hard wood, although pine will do if a higher grade of wood is not at hand. The five holes drilled in the holder are drilled nearly through the block, in order to permit the tools to get as long support in the block as possible. Otherwise they are liable to fall out easily, and are a constant annoyance. The blocks with the sets of taps and drills are kept in the tool room. This system saves much time ordinarily lost in hunting for the proper drills for a certain size of taps.

Winamac.

CHUCK CLOSER FOR SCREW MACHINE COLLET.

The chuck closer shown in the accompanying cut is inexpensive and very practical in a small tool-room, where the management will not furnish a tool-maker's lathe with draw-in

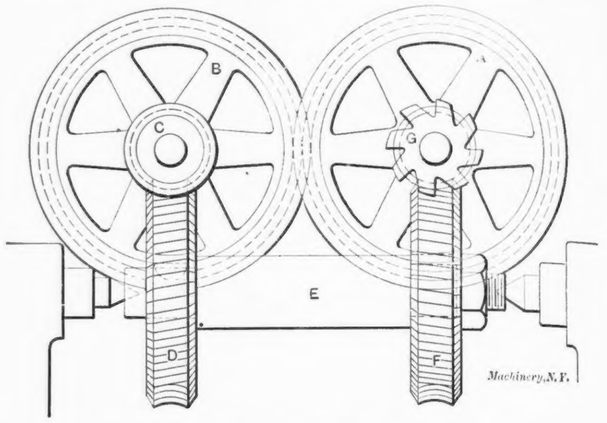


chuck. The holder A screws onto the lathe spindle, the closer B, in turn, screws onto the holder, and the collet C is held in the holder and acted upon by the closer. F. J. Perry.

Lowell, Mass.

RIG FOR HOBBING WORM-WHEEL.

In the cut is shown a hobbing rig for worm-wheels, used on a milling machine. This rig consists of two gears A and B, meshing with one another, one worm C, one worm-wheel D, and an arbor E. F is the worm-wheel which has just been hobbed, and G is the hob. This hob is mounted on an arbor inserted in the spindle of the milling machine in the usual way, and the gear A is mounted on the spindle also. A special bracket is placed on the milling machine table for holding the gear B and the worm C. The arbor E is placed between the centers on the table, and the worm-wheel D meshes with the worm C mounted on the same stud as gear B. The worm-wheel and worm must be of the same pitch and of the same diameter, respectively, as the hob and the worm-wheel to be cut, but must have the teeth cut in the opposite direction; that is, if a left-hand worm-wheel is to be cut, the guiding worm-wheel D must be right-handed. This rig enables gears to be hobbed or cut in one operation by simply putting the gear blank on the arbor, inserting it between the centers as indicated, and feeding the table upward until the proper

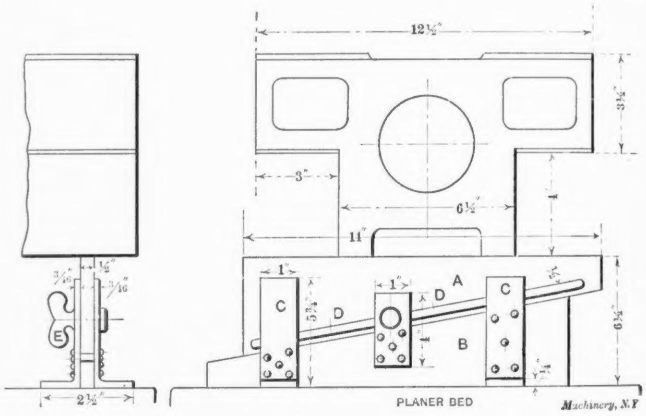


depth is reached. Gears from 2 to 6 inches in diameter can be cut very quickly with this arrangement.

Chicago, Ill. A. Andrews.

DEVICE FOR SUPPORTING AND LEVELING CROSS-HEADS.

In the line cut herewith is shown a device for supporting and leveling a cross-head which is supposed to be resting in a V-block on the planer. The device needs but little explanation, as it simply consists of two wedges A and B, the latter being



stationary and provided with four angle irons C C, which serve as feet and at the same time extend upward and act as guides for the top wedge A. The slot D allows motion to the upper wedge endwise. Through this slot passes the thumb screw E, binding the wedge when driven into place. By lightly rapping in the wedge before the work is tightened down, it at once assumes a position parallel to the planer table, thus eliminating much trouble in measuring and calipering. This device has proven to be a great convenience, and to be much handier and quicker than any other method. It supports the work in a substantial manner, and it saves time.

Clinton, Iowa. H. W. Harrison.

INSPECTING INSIDE THREADING IN SMALL HOLES.

It is always desirable to be able to inspect closely the interior of a hole of small diameter, especially when threading it. For this purpose a slip of mirror is often recommended. Something still better is a dentists' little concave mirror, aided by an electric incandescent lamp and a concave mirror; but best of all, up to date, is a new dentists' appliance, consisting of a handle about as large as a stylographic pen, and containing a tiny incandescent lamp with mirror in the holder, while a second concave mirror is attached to the end of the holder at such an angle as to permit its use in the mouth or a bored hole. I suppose S. S. White & Co., of Philadelphia, make such an appliance; in Europe they are made by C. Ash & Son, London and Berlin. Robert Grimshaw.

Hanover, Germany.

SHOP RECEIPTS AND FORMULAS.

A DEPARTMENT FOR USEFUL MIXTURES.

This page is intended to be used only for the publication of such shop receipts as the contributors know from experience to be practicable. Receipts are solicited on the condition that the contributors personally know that they are reliable. The fact that a receipt is old and supposedly well-known does not bar it, provided it has not already appeared here.

366. WATERPROOF MARKING PAINT FOR STONE.

To prepare a marking paint for use on stone where exposed to the water and dampness, use pitch, 11 pounds, lamp black, 1 pound, and heat carefully, adding sufficient turpentine to give the mixture the desired consistency. M. E. CANEK.

367. COATING IRON OR STEEL.

Iron or steel may be given a permanent coating of yellow brass by using a flux of boracic acid and then dipping into a pot of melted spelter, afterwards wiping off the article while still hot. The electro-plating process, however, is the best for this purpose. A coating of copper should then first be deposited on the steel, the same as if it were to be nickel-plated, and then follow with an electro-plating of yellow brass.

Cleveland, Ohio. L. MILLER.

368. TO CLOSE CRACKS IN CASTINGS.

The following mixture has been successfully used in filling cracks in gas engine water jackets, and is similar in nature to the ordinary rust joint mixtures. Prepare a dry mixture of 17 parts of cast-iron filings, 2 parts of sal-ammoniac, and 1 part of flour of sulphur; add twenty times the weight of new iron filings, put in a mortar and add water so as to obtain a paste. This paste is applied to the crack, and in a short time becomes as hard as the metal itself. M. E. CANEK.

369. CEMENT FOR UNITING GLASS AND BRASS.

It is often necessary, in electrical factories and repair shops, to cement small brass parts to glass. A good cement for this purpose is made from the following: 1 part caustic soda, 3 parts resin, 3 parts plaster of paris, 5 parts water. Boil all the constituents together until thoroughly mixed, and then allow to cool before using. The cement hardens in half an hour. If it is desired that it should not harden so quickly, substitute zinc white, white lead, or slaked lime, for the plaster. T. E. O'DONNELL.

Urbana, Ill.

370. CEMENT FOR SWITCHBOARD REPAIRS.

A good cement for making repairs on switchboards, when iron or other metal has to be fastened to marble, or where binding posts have been pulled out, may be made to consist of 30 parts plaster of paris, 10 parts iron filings, and ½ part of sal-ammoniac. These are mixed with acetic acid (vinegar) to form a thin paste. This cement must always be used immediately after being mixed, as it solidifies if allowed to stand for any length of time. It will be found to be an excellent means for filling up old binding-post holes, when instruments have been moved. T. E. O'DONNELL.

Urbana, Ill.

371. CEMENT FOR HIGH-PRESSURE WATER PIPE JOINTS.

A highly recommended packing and cement, combined, for making tight joints in high pressure water pipes, is made as follows: Mix with boiled linseed oil, to the consistency of putty, these ingredients: Ground litharge, 10 pounds; plaster of paris, 4 pounds; yellow ochre, ½ pound; red lead, 2 pounds; cut hemp fiber, ½ ounce. The hemp fiber should be cut in lengths of about ½ inch, and thoroughly mixed into the putty material. Its office is to give consistency to the cement. The cement is applied to the joint similarly to any other cement. It dries thoroughly in from 10 to 12 hours.

Urbana, Ill. T. E. O'DONNELL.

372. FOR WASHING SHOP WINDOWS.

Soap and water are poor materials with which to wash greasy and dirty shop windows. The labor cost is excessive; the soapy water gets into the joints of the window sashes and hastens decay; and there is liable to be a good deal of soapy water slopped over benches, tools and machines. The quick way, the economical way, and the good way, is to use the following preparation, which has been used by the writer with good success and satisfaction for the past ten years. Dilute alcohol with three times its bulk of water. Stir into this whiting enough to thicken it somewhat. Apply this to the glass with a cotton cloth or waste. Leave it fifteen or twenty minutes to dry. Then rub off with a cotton cloth or a handful of waste. If sashes are to be painted, there will be no need of a long wait for the wood to dry, as the alcohol will very much hasten the evaporation of the water and leave the woodwork in fine condition for the painter. OSCAR E. PERRIGO.

Peabody, Mass.

373. TO PREVENT HOT LEAD STICKING TO WORK.

About three years ago we had a new quick-break switch to manufacture in large quantities. One piece of the switch was required to be hard at one end and soft at the other. We tried several methods of annealing so as to leave one end hard, but found that the temper was drawn throughout, and all were rejected. We finally decided that a hot lead bath was the only way that would anneal one end and leave the other end hard, but we then encountered the difficulty of the hot lead sticking to the work. A number of receipts were tried for preventing it without success, but finally I discovered a process that is quick and very cheap. Mix common whiting or cold water paint with wood alcohol and paint the part that is to be annealed. The hot lead will not stick, no matter how long the piece is held in the pot. Of course, in the work mentioned, the pieces were lowered quickly into the hot lead and removed as soon as possible, in order to prevent drawing the temper of the hard end, and then the whole was plunged in a pail of cold water. Water will do as well as alcohol to mix the paint, but alcohol is the most convenient inasmuch as it can be used without waiting for the paint to dry. If water is used, the paint must be thoroughly dry, as otherwise the moisture will cause the lead to fly. E. J. LAWLESS.

Pittsfield, Mass.

374. LACQUER FOR BRASS.

I have found that the following process makes a very good lacquer for the brass parts of fine instruments, and that it requires but little labor to prepare. Make four alcoholic solutions in separate bottles of each of the following gums: unbleached shellac, dragon's blood, annatto, and gamboge, in the proportions of about one ounce of the gum to a pint or alcohol. Keep these solutions about a week in a warm place, on a hot water or steam radiator, for instance, shaking the bottles frequently. It will be found that the alcohol will not dissolve all of the gum, but that within half an hour after shaking, a precipitate will settle on the bottom of the bottle, leaving a perfectly transparent but highly colored liquid above, which deepens in color from day to day. Decant this off, and filter through cloth, placing the liquids in tightly corked bottles. A word of caution should be given in the case of shellac. Most readers of MACHINERY are familiar with the yellow opaque shellac varnish of the pattern-maker. This is useless. But if the above proportions are used, and the solution kept warm, say 130 to 180 degrees F., a light flocculent precipitate will settle out, leaving a transparent wine-colored liquid above. It is this liquid which must be used. The four solutions should now be mixed. Equal parts of each give a rich golden yellow. After mixing, the solutions should be boiled down to about one-third of the volume, great care being used not to ignite the alcohol. Heat a piece of cast-iron over a Bunsen burner, and as soon as this is hot, turn out the burner and place the solution on the iron and allow it to boil. When it ceases to boil, repeat the process. When cold, this solution may be applied with a brush to the brass in the usual way, the brass having been polished with fine jewelers' emery paper, and slightly warmed. Though slightly harder to apply than the commercial lacquers, it possesses none of the disagreeable odor of the banana oil which they contain.

Columbus, O. H. C. LORD.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

C. H. A. I would like to ask the readers of MACHINERY what I can do to remedy the following difficulty: When copper-plating cast iron by dipping in a copper sulphate solution, the castings have been turning dark and rust while drying, whether dried in sawdust or open air. I have tried thoroughly cleaning in caustic soda. Is there any sure way of doing this plating by dipping in copper sulphate ($CuSO_4$) so as to obtain a plating that is good? What are the correct solutions and best methods?

CALCULATIONS FOR SHORT TOOTH GEARS.

L. A. F. What is the meaning of "11/14 pitch," a term which I found applied to an internal gear and its pinion on a drawing in my possession? How can I figure the pitch and outside diameters for an internal gear having 138 teeth meshing with a spur gear having 60 teeth, 11/14 pitch?

A. The fractional pitch referred to without doubt relates to a method of designating a short tooth form of gearing, which has been considerably used, especially in automobile work. The figure 11 in the numerator of the fraction refers to the actual diametral pitch of the cutter, and should be used in all calculations relating to the pitch diameter. The figure 14 in the denominator indicates that the length of the tooth is the same as that of the 14-pitch size, although the pitch is really 11. The pitch diameter of the 138-tooth internal gear would be $\frac{138}{11} = 12.5454$ inches. The pitch diameter of the 40-tooth gear will be $\frac{40}{11} = 3.6363$ inches. In reckoning the outside diameter of the pinion and the inside diameter of the internal gear, proceed as if the gear were 14 pitch. The addendum (the distance the tooth extends above the pitch line) for a 14-pitch gear equals $\frac{1}{\text{pitch}} = \frac{1}{14}$. Twice the addendum added to the pitch diameter will give the outside diameter of the pinion, $3.6363 + 2/14 = 3.7791$ inches; likewise, $12.5454 - 2/14 = 12.4026 =$ inside diameter of internal gear.

In a system in common use and recommended by the Fellows Gear Shaper Co., of Springfield, Vt., this short form of tooth has a length of as nearly ¾ the standard length as can be expressed in the form of an even diametral pitch. That is to say, if we wish to express in fractional form the pitch of a short 11-pitch tooth, we have: $11 \div \frac{3}{4} = 14 +$; 14 will then be the denominator of the fraction, giving us 11/14, as was stated by our correspondent. In the Fellows form of gearing mentioned, the pressure angle is made 20 degrees instead of the standard 14½ degrees of the ordinary gear cutter. This gives a stronger tooth, and one with less interference as well in the case of low numbered pinions.

COUNTERBALANCING CRANK-SHAFTS.

D. L. Please give me a formula for finding the balance weights that I want for a two-cylinder four-cycle gasoline motor with a crank-shaft like that shown in Fig. 1, in which *B* are the journal bearings, and *P* the crank-pins.

A. It will not be possible to give you any definite formula for solving this problem. The matter of balancing an engine arranged like this is a compromise; it cannot be balanced

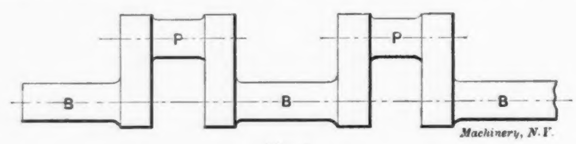


Fig. 1.

completely. The rotating parts may be taken care of, but it is impossible to absolutely balance the piston and connecting-rod by rotating counterweights. The following solution, however, is offered as representing average practise. It should give a fairly quiet engine: First find the amount of counterweight required for balancing the rotating parts. Aside from the connecting-rod and its parts, it is assumed that the crank-shaft itself is the only unbalanced revolving weight. Support this, as shown in Fig. 2, on the ways of a lathe or any other convenient level track, so that the main journals are free to roll on the top of the ways. Suspend one of the crank-pins from a wire loop hung from a spring balance. With the center line of the crank horizontal, and the spring balance hold vertically, note the weight shown on the scale. Add to this 75 per cent of the weight of the connecting-rod with the brasses, oil cups, etc., in place, and 60 per cent of the weight of the piston with its rings, wrist-pin, etc. The result, which we will call W_1, will be the weight necessary to approximately counterbalance the engine when the weight is located with its center of gravity directly opposite the cranks, half way between them, and at a distance equal to the throw of the crank from the center line of the crank-shaft. Since it will not be feasible to locate the counterweight in this way, it will be necessary to distribute it in two or more separate portions according to the rules illustrated in Fig. 3. Calling the weight just obtained W_1, and the crank radius R_1, we have $W_1R_1 = W_2R_2$, where R_2 is any other radius, and W_2 the corresponding weight required. This weight W_2 may be divided, one being moved to one side and one to the other in double flywheels, for instance, or on the outer crank arms if desired. If they are moved equal distances, *b*, to either side of the center line, the weights may be evenly divided as shown. No matter how the counterweights are distributed, however, or what their number may be, the center of gravity of the

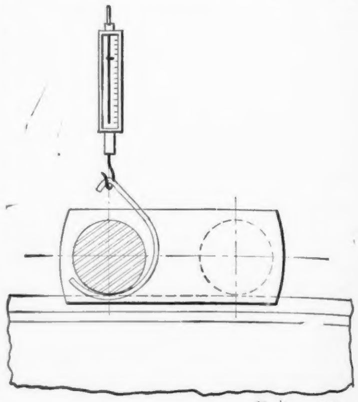


Fig. 2.

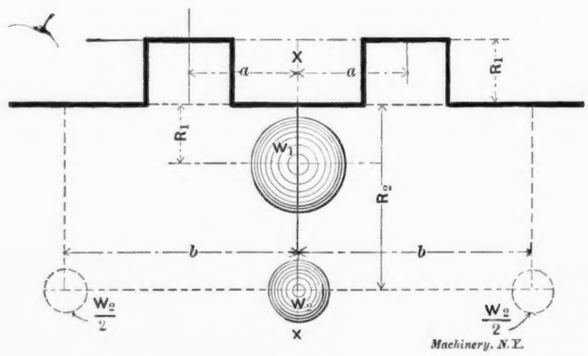


Fig. 3.

whole of them taken together must lie in the center line *xx*, and the sum of their weights must be such that, multiplied by the distance of their center of gravity from the axis, it will equal W_1R_1. If you have a little knowledge of mechanics, or are willing to study the subject, you will find more accurate methods of counterbalancing discussed in various text-books. Of these we would recommend Goodman's Mechanics Applied to Engineering, published by Longmans, Green & Co., New York, and Steam Engine Theory and Practise, by William Ripper, published by the same firm.

One of the causes of unexplained failures of tools is the bad practise often followed by toolsmiths of nicking a steel bar cold and breaking it off. While it is a convenient method, it should not be followed as common practise, but in case a bar is cut in this manner, the fractured end should be cut off at a low heat with a hot chisel. Mr. Taylor, in his notable presidential address, calls attention to this practise, saying that it is a common cause of slight invisible cracks, which may not fully develop until the tool is in use. Tool steel is a peculiar material and there is much about its structure that is not understood, but it is pretty safe to say that anything seriously affecting the molecular structure while in the cold and solid state should be carefully avoided.

NEW MACHINERY AND TOOLS.

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP.

THE PRATT & WHITNEY OPEN TURRET LATHE.

This article, with its accompanying half-tones and line cuts, describes a new form of turret lathe developed by the Pratt & Whitney Co., of Hartford, Conn. They call it the "Open Turret Lathe," one of the principal points of novelty being the method of clamping the turret tools in position. In bringing out this machine it has been the aim of the builders to produce a universal tool, suitable for doing a great variety of work from the bar as well as on forgings and castings, without requiring special appliances and expensive cutting tools. To accomplish this purpose, many new features, including a cross sliding turret, have been introduced. Particular attention has been paid to rigidity of the whole structure, to power in the drive of the spindle, to the furnishing of quick changes of speeds and feeds, and provision for numerous adjustable stops so arranged as give narrow limits of error for both longitudinal and cross movements. Besides this, the machine possesses, to a great degree, the flexibility and adaptability of the engine lathe.

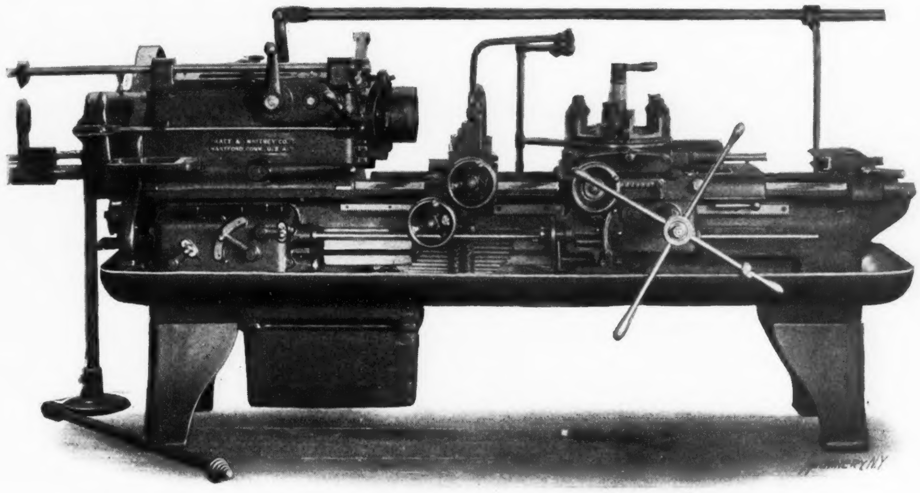


Fig. 1. General View of the Open Turret Lathe.

Design of Head-stock and Spindle.

A general view of the machine is shown in Fig. 1. The head-stock is of the single-speed driving-pulley, and all-geared type, with the mechanism enclosed in a case and subject to constant lubrication. A view of the head-stock with cover removed is shown in Fig. 2. The direction and speed of the spindle are governed entirely by friction clutches controlling the transmission gearing. The starting, stopping and reversal of motion is obtained by lever *A*, operated by the rod extending across the back of the machine as shown in Fig. 1. Levers *B* and *C* operate each two friction clutches, any one of which may be engaged, to give the speed it controls. These clutch levers are operated in an interesting manner. At the front of the machine is a handle *D*, which, by the gearing shown, rotates cam shaft *E* and cams *F* and *G*, which operate clutch levers *B* and *C*. Handle *D* may be set in any one of four positions to engage either of the four clutches. The cams are so arranged that a complete revolution of the handle will engage them in turn, in their proper order to give a consecutive increase or decrease in speed, without the possibility of engaging two at a time. This is much more convenient than having to operate the clutch levers directly, with the possibility of making mistakes in their engagement. A further change of speed is obtained by the horizontal lever shown near the base of the head-stock in Fig. 1. This operates what corresponds to the back gears in an ordinary lathe, multiplying the changes otherwise obtainable by two, giving eight in all. This is ordinarily sufficient, but a two-speed countershaft may be used if desired.

The spindle is unusually heavy, of special steel, and runs in cylindrical bearings in bronze sleeves. These fit conical seats in the head, and are adjusted for wear by being drawn in and locked in position by annular nuts at either end. The thrust of the spindle is taken against an independent upright, shown at the right of the large driving gear. This is cast solid with the head and insures against any springing tendency of the spindle under heavy end cutting strains. Wear in the thrust bearings can be adjusted as it occurs.

The Automatic Chuck.

A sectional view of the chuck for bar stock is shown in Fig. 3. The outer sleeve *J* slides under the influence of the chuck lever, on the body of the chuck *K*, which is screwed to the spindle *L*. The chuck jaws *M* fit in a double conical seat in the body of the chuck, and are well supported at their extreme outer end, a matter which is particularly desirable in forming work with the cross slide. A lip is formed at the rear end of the four separate pieces composing a set of chuck jaws. This lip enters a recess formed in the closing piece *N*. This closing piece is normally forced outward by a set of springs (of which one is shown in the cut) acting on studs screwed into its periphery. The chuck jaws are thus forcibly opened when not otherwise constrained. To close them, struts *O* are provided, one end of each bearing against a seat on closing piece *N*, while the other abuts against sleeve *J*, and adjusting ring *P* threaded to the body *K*. When the outer sleeve is slid backwards to the extreme limit of its travel, the ends of the struts are allowed to drop into the space left by the enlarged inner diameter of sleeve *J*, thus presented. This allows

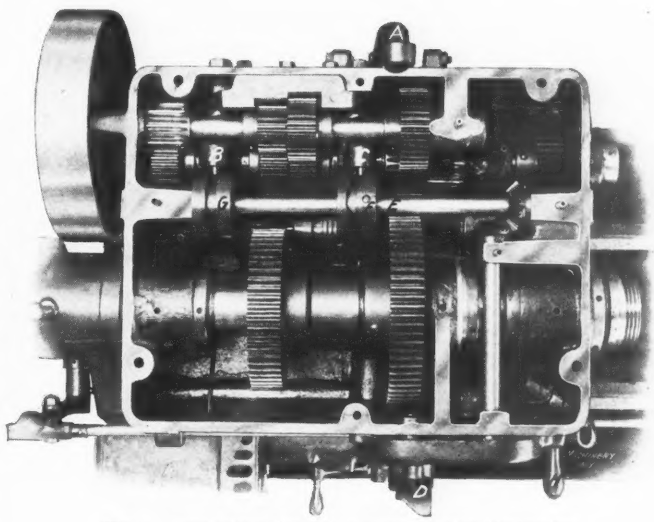


Fig. 2. Head-stock Opened to show Driving Mechanism.

closing piece *N* to be pushed forward by the springs, and the chuck jaws to be opened. The reverse action takes place when the chuck is closed. The various parts of the mechanism are hardened, the jaws as well as the cylindrical moving parts being hardened and ground. The complete chuck can be readily removed from the spindle, when combination lathe chucks or special face-plates may be substituted.

Rod Feed Mechanism.

The lever which opens and closes the jaws of the chuck also controls the rod feeding device. Various lever feeds, weight feeds, friction feeds, and roller feeds have been tried for screw machines, but the builders of this tool have satisfied themselves after long experiment, that nothing has been found

to equal the positive screw feeding device for moving the bar stock forward to its stop. The bar that is to be fed may be round, square, hexagonal, or of any cross-section, and need not necessarily be free from scale, as there are no delicate parts or complicated gearing to become clogged thereby. Details of this mechanism are shown in Fig. 4.

The lever controlling the chuck, operates the feed mechanism by the long connecting link seen in Fig. 1. When the

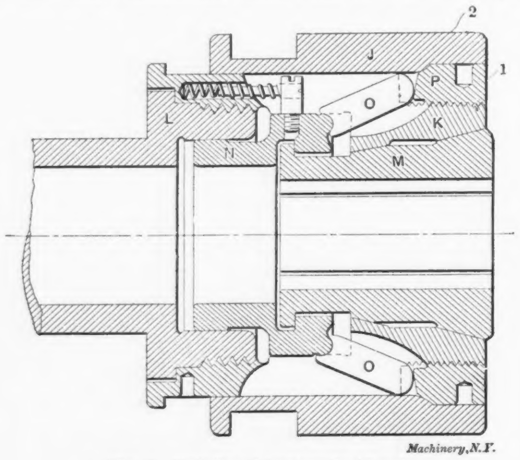


Fig. 3. Details of Automatic Chuck.

jaws are open, clutch Q, together with the coarse pitch feeding screw R, is moved to the right, until it engages with a clutch on the face of gear S, which meshes with gear T on the rear end of the spindle. This gear rotates positively in one direction only. When the two clutches are engaged, the feeding screw rotates, causing the rod follower U to bring the bar of stock forward, acting on it through the collar V which is clamped to the bar. The movement of the bar is arrested by an adjustable swinging stop in front of the head. This stop, best seen in Fig. 1, consists of a stiff swinging arm

automatically disengaged in a similar manner. A follower bar is furnished which enables short pieces of stock to be as conveniently handled as long bars, at the same time keeping such pieces concentric with the spindle.

Design of Turret and Turret Feed Mechanism.

The form of the turret is the result of considerable thought. It is the outcome of the recognized necessity for locating the various tools with precision, and giving them at the same time a rigid backing so that heavy cuts, facing, etc., can be accomplished without spring or displacement. These features, with a rigid binding device for clamping the turret to the base, are incorporated in the design shown. This is best seen in Fig. 5. The binding device provided permits long bars to pass through a hole in its center. This feature is common to all Pratt & Whitney turret lathes. The experience of the builders has inclined them to the belief that, even with accurately dimensioned lock bolts and close fitting turrets, more bad work and annoyance has been caused by loosening of the turret than by any other feature on machines of this class. The locking bolt is accurately fitted to the slide with means for taking up the wear without disturbing any other detail. An important point in favor of the horizontal locking bolt as compared with the vertically moving variety, is that the tendency to lift the turret from its seat by the thrust of the lock bolt spring, is obviated. The method of withdrawing the lock bolt and indexing the turret does not require any overhanging bars or increased floor space beyond that taken by the bed. The indexing is automatic, although it is possible to rotate the turret directly by hand when desired.

The power longitudinal feed is positive in both directions, and has six changes, any one of which may be instantly set by the movement of a lever; the changes are accomplished by a sliding key without stopping the spindle. There are six automatic longitudinal stops, and six supplementary ones, giving twelve stops in all which may be used for one or all of the tools in the turret. These stops are held in a heavy steel

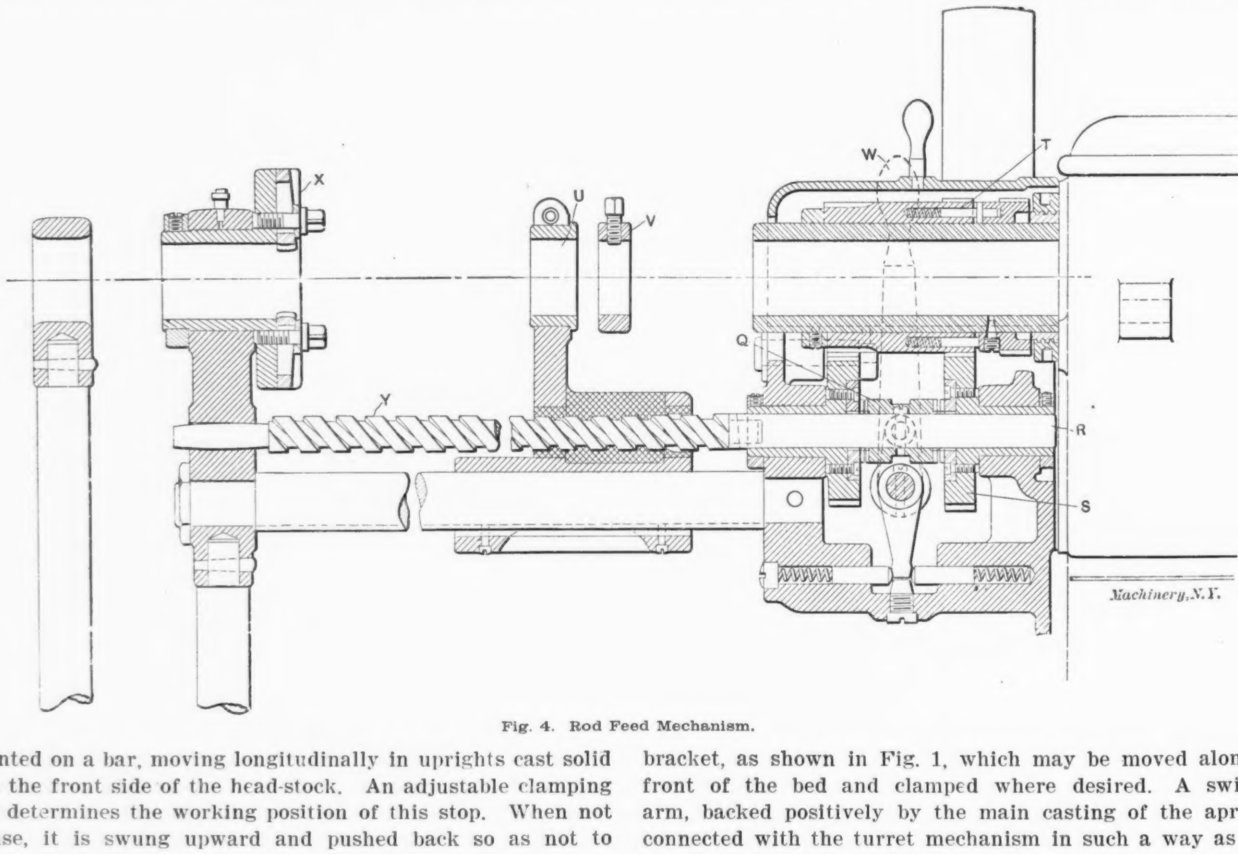


Fig. 4. Rod Feed Mechanism.

mounted on a bar, moving longitudinally in uprights cast solid with the front side of the head-stock. An adjustable clamping ring determines the working position of this stop. When not in use, it is swung upward and pushed back so as not to interfere with the tools.

When the movement of the bar of stock is arrested by coming in contact with the stop, the effect of this resistance is to cause the follower U to become stationary, together with the revolving feed screw R, whereupon clutch Q automatically releases itself from the clutch on the face of gear S. By throwing the clutch lever to the left, the follower may be returned to its rearward position, where the screw becomes

bracket, as shown in Fig. 1, which may be moved along the front of the bed and clamped where desired. A swinging arm, backed positively by the main casting of the apron, is connected with the turret mechanism in such a way as to be shifted to one of six different positions in turn, as each of the six faces of the turret is presented to the spindle. For bringing the abutment in line with the intermediate stops, a latch is provided which frees the swinging arm from the control of the turret. The supplementary stops will be found useful when the regular ones have been previously adjusted to suit a long run of work which it is not desired to change. A short job may be put through the machine by using these

supplementary stops, without disturbing the original adjustment, after which the machine may go back to its regular work. The mechanism being at the front of the machine, it is particularly accessible, and its location is such as to prevent lodgment of dirt and chips at the acting surfaces, and thus cause a variation in the turret position.

An important feature in the design of this lathe is the compound turret slide, giving either longitudinal or cross feed by hand or power, with rigid and numerous positive stops provided for both movements. When it is desired to use the

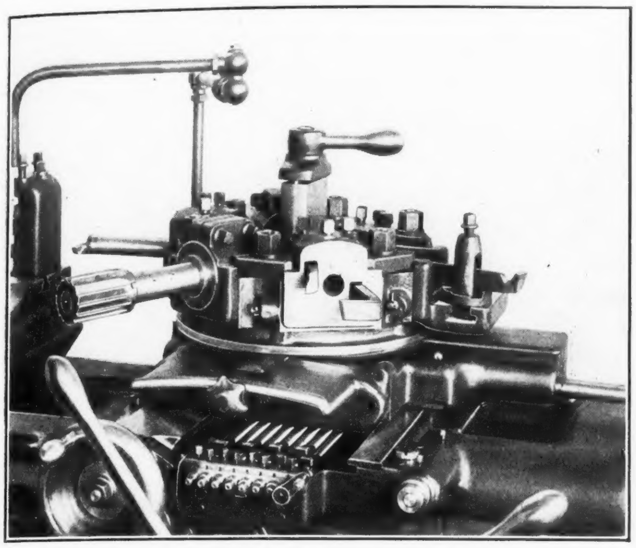


Fig. 5. General View of Turret with a Set of Tools for Castings in Place.

cross feed, the carriage may be clamped firmly to the ways at any point in its travel. Eight positive stops for the cross movement are provided. These are best seen just beneath the cross slide in Fig. 5. They may be quickly adjusted and locked by the crank shown. The knob at the front of the cross slide just above them brings a positive abutment within range of any one of them.

The power cross feed will be found very useful in facing large diameters. In order to guard against the breakage of the gearing which operates the feed, an adjustable friction driving device is used. A central position of the turret is often required, especially when using drills, reamers, dies, taps, etc. To furnish a central stop, the nut for the cross feed screw is brought against a stop plug firmly fixed in the bottom slide, there being no intermediate parts to produce accumulated errors. This arrangement provides an accurate means of locating the turret.

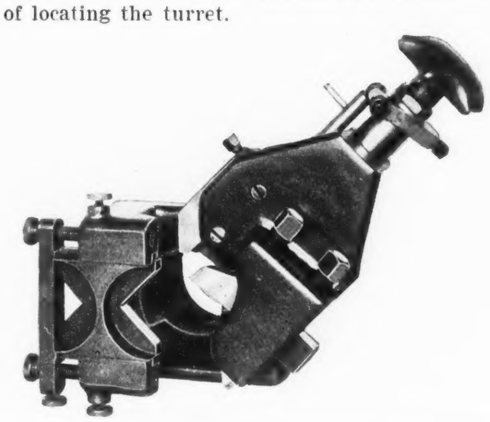


Fig. 6. Standard Turning Tool for Bar Stock and Forgings.

The traverse movement of the spindle head, and the similar movement of the turret slide, are the only methods possible of altering the distance from the axis of the spindle to the center line of the various tool-holders used. Both methods have been practically applied. The former has the disadvantage of leaving long bars of stock projecting from the rear of the spindle without support, when bar work is being done. There is also the trouble of attaching motor drives, due to extra weight if fastened directly to the head, and to the varying belt tension when the head is otherwise driven. Besides, the action of the turning tools and belt strain is to lift the head and hold down the turret slide, and these forces are in opposition. With the plan used in this machine, all strains in the cutting tools in turning, facing, forming, cutting-off, etc., are downward, tending to hold the parts of the compound slide more firmly together, and communicate the pressure to the unyielding bed. Long bar work can always be supported at the rear of the spindle by stock supports, nor are difficulties presented by either motor or countershaft drives.

A special forming cross slide shown in place on the machine in Fig. 1 will be furnished to order. This is used for heavy forming done on bar work or small castings. The feed is by hand-wheel and screw. It has a longitudinal hand feed on the bed in addition to its cross feed, through the hand-wheel shown, with attached gearing meshing with a rack underneath the way of the bed. When using the turret close to the spindle, the cross slide is moved directly under the spindle nose and does not in the least interfere with the turret.

The Turret Tools.

A number of interesting turret tools have been designed for use with this machine, both for bar work and castings. The principal tool used on bar work is the universal turner, shown in Fig. 6. This is similar in design to the turning tools used on the smaller screw machines built by the same firm. It will take cuts up to $2\frac{1}{2}$ inches in diameter, and may be used when turning toward the spindle, as is usual on short work, or away from it, which is frequently desired on long, slender work. The blade is of high-speed steel held in a slot in the tool-slide by two set-screws. This blade is of the "over-shot" type, cutting on its end. It is set for the diameter desired, by adjusting the slide on which it is mounted, by means of the knob shown, with its attached screw. A positive stop is provided, which makes it possible to withdraw the tool from the

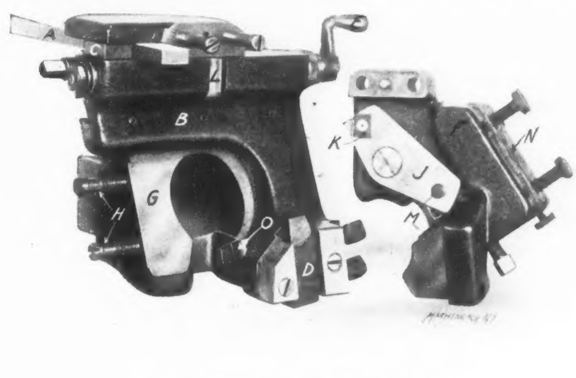


Fig. 7. Automatic Taper Turning Tool.

work and bring it back again accurately to size as often as is necessary. The back rests are of the V-type, quickly and conveniently adjusted to present the correct relation to the cutting tool. The adjustable strap which holds them in, may be quickly swung out of the way to remove them when passing over shoulders, changing cutting tools, etc. This may be done without altering the adjustment. The tool is also furnished with roller back-rests for high-speed roughing operations.

Another interesting tool is the taper turning device, shown in Fig. 7. The taper bar shown at *A*, at the forward movement of the turret, strikes a stop on the head-stock which forces it backward as the tool advances. A lateral motion is thus given to slide *B* from the action of the taper side of the bar on block *C*, which is pivoted to the slide. A block is used at this point instead of a roller to insure permanent accuracy of action. Slide *B* carries the turning tool *D*, which is adjusted for diameter by handle *E*, provided with a graduated collar. Casting *F*, shown removed in the cut, is normally fastened to the body *G* of the tool by screws *H*. This casting has pivoted to it a lever *J*, carrying a pivoted block *K*, which slides in the groove *L* in slide *B*. The other end of lever *K* is pivoted at *M* to a block engaging a slot in slide *N*, which carries the adjustable back-rest jaws. It will be seen from this that, with the parts correctly proportioned, the cross movement of the tool *D* in turning the taper will be duplicated by slide *N*, in the proper ratio to keep the back-rest jaws

always in contact with the work. To insure ease of action, the pressure of the cut against slide *B* is taken on a roller, *O*, instead of against a sliding surface. For work on forgings, the back-rest jaws are set to follow the cutting tool, and move as described to suit the varying diameters produced. For bar work, however, in case bright rolled stock is used, the slide holding the back rest jaws is clamped to prevent movement, and the jaws reversed so as to precede the cutting tool.

The method of holding the tools in the turret is best seen in Fig. 5. The bodies of the various tools are machined with rectangular surfaces to fit the planed seats in the "open turret" used. They are held in place by the short straps shown between the tools. Fig. 5 shows the machine set for work on castings, and the functions of the various cutter-holding devices there used will be readily understood.

Among the other tools furnished are: an open side turner for use instead of the universal turning tool on short, stiff work; a bell mouth pointing tool; an end forming and pointing tool; a turret cutting-off and forming tool; a self-opening die, etc. For castings, a triple tool-holder for boring and turning is furnished, together with end facing and recessing tool, facing and boring tool-post holder, offset single and double tool-post holders, boring bars with adjustable cutters, tap and reamer holders, etc. Fig. 8, which shows the machine set up for casting work, will give some idea of the practise followed in operations on cast iron, etc.

A number of work-holding devices have been designed for this machine. In Fig. 9 is shown a patented step chuck and

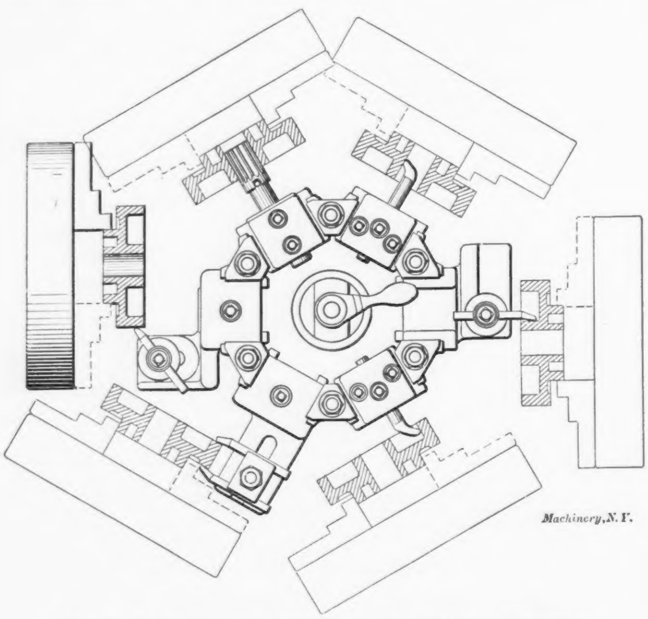


Fig. 8. Typical Layout of Operations for Finishing a Casting.

closer, with adjustable jaws. The chuck itself, *A*, is made of steel, split in four places, each section having a beveled slot. In these slots are held the four adjustable jaws *B*. In setting this device for a second operation on a piece (such as finishing a gear blank on the side previously held in the chuck) these jaws *B* are first adjusted to approximately correct position. A plug is then inserted in the hole in the center of the closer *A*, of the same diameter as that hole. Then the step chuck is closed by the mechanism at the rear of the spindle, this consisting of an eccentric operated by a wrench. The boring tool is then brought forward from the turret, and the jaws are "stepped out" to the desired diameter, which will be the same as the diameter of the finished end of the piece made in the three-jawed chuck in the first operation. The closing mechanism is then released and the plug removed. The work is inserted in the jaws, and the chuck then closed. The work will then run absolutely true, on exactly the same axis as it revolved on during the first operation; so the second operation will be exactly concentric and parallel with the first. The jaws are made of soft machinery steel, but when used up, they are easily replaced with soft steel pieces of any shape desired. The largest capacity of the chuck is 12 inches.

For centering and turning forged bolts, the heads of which may be more or less eccentric, two chucks are used; a lever scroll chuck mounted in one of the turret slots, and a forging chuck with two floating jaws, carried by a shank fitting the regular 2-inch chuck jaws in the spindle. The body of the bolt is placed in the scroll chuck on the turret, its head coming where it may. The turret is advanced by hand until the head comes between the jaws of the forging chuck, which are then closed by the right and left-hand screw, gripping the bolt head. The scroll chuck is then opened, the turret run back and indexed to the first turner required, and the turning proceeded with. These two chucks are especially recommended for use in railroad shops.

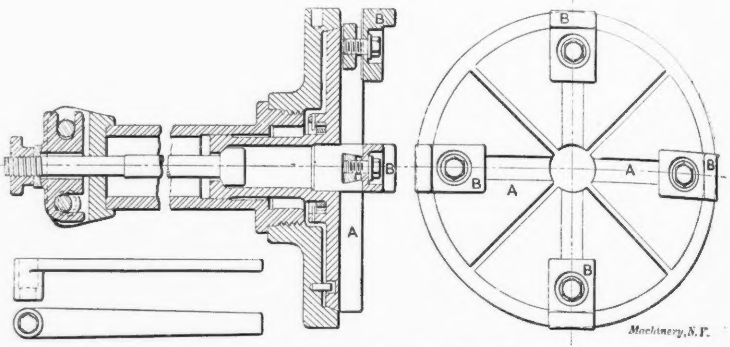
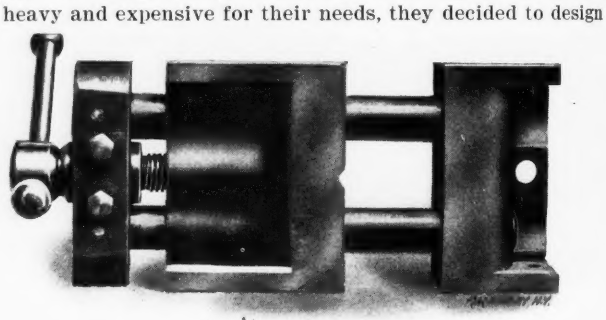


Fig. 9. Step Chuck for Second Operations.

The machine swings 19 inches over the bed and 10 inches over the forming slide. There is a 2⅝-inch hole through the spindle. The largest standard collet provided is 2 9-16-inch. The greatest length that can be turned is 26 inches. The driving pulley is 14 inches in diameter for a 3-inch belt, and sixteen feeds are obtainable with a two-speed countershaft.

THE TITUS DRILL PRESS VISE.

The Titus Machine Works, of Marion, Ohio, is building the simple and inexpensive drill press vise shown in the accompanying halftone. This tool is the outcome of the experience in manufacturing of the men who build it. They had had considerable trouble in their own shop practise in firmly holding light and irregular work for drilling, and a consequent excessive amount of breakage of drills. Having decided to remedy the difficulty by equipping the plant with some kind of vise or chuck for the purpose, and finding everything on the market too heavy and expensive for their needs, they decided to design



Drill Press Vise of Practical but Inexpensive Construction.

a tool of this kind. The vise they developed was so satisfactory to them that they have decided to manufacture it, and place it on the market.

As will be seen in the cut, the tool is remarkable for its simplicity. Its framework consists of two guide rods of tool steel (hardened so that they cannot be sprung or be injured by drilling into them) inserted at one end in the fixed jaw of the tool, and carrying at the other end the yoke in which the adjusting screw is seated. This screw is of steel, with a heavy thrust collar turned from the solid. It is threaded into a brass nut having a liberal thread surface, securely seated in the movable jaw, which slides along the guide rods and is supported by them. The jaws are 5 inches wide, 3 inches deep, and open 3 inches. They are accurately planed on all sides and one end. The movable jaw has V-grooves for holding

round pieces both vertically and horizontally. The design of this vise makes it light to handle and at the same time strong and durable. There are no blind pockets to become clogged with chips or dirt. It will sit firmly on the bottom or edge. It cannot be injured by drilling into it. In spite of these advantages, its design is such that it is remarkably inexpensive. The builders are willing to send samples to responsible firms on thirty days' trial.

EBERHARDT BROS. NO. 2-B AUTOMATIC SPUR AND BEVEL GEAR CUTTER.

The Eberhardt Bros. Machine Co., 66 Union St., Newark, N. J., is building the small-sized automatic spur and bevel gear cutter shown in the two accompanying halftones. This machine is designed for the work of which there is the largest quantity in the ordinary machine shop. It has an extreme capacity for a blank 24 inches in diameter and 6 inches face, and will cut teeth of 8 diametral pitch in steel at a good feed. This capacity includes such work as lathe and milling machine change gears, feed and adjusting spur and bevel gears, as well as other kinds of automatic milling, including the cutting of face clutches, cutters and saws, and all cylindrical or conical work of a similar nature where accuracy and rapid production are essential.

The construction follows the general design of the line of machines built by this firm, modified somewhat to suit the smaller size. Among the modifications may be noted the bevel gear drive to the cutter spindle in place of the spur gearing used on the heavier machines. The changes of speed are obtained by gears, immediately driving the bevel pinion. The cutter arbor is solid with the spindle. The cutter slide and feed mechanism are supported on an adjustable segment, which may be set at an angle by means of a worm, meshing with

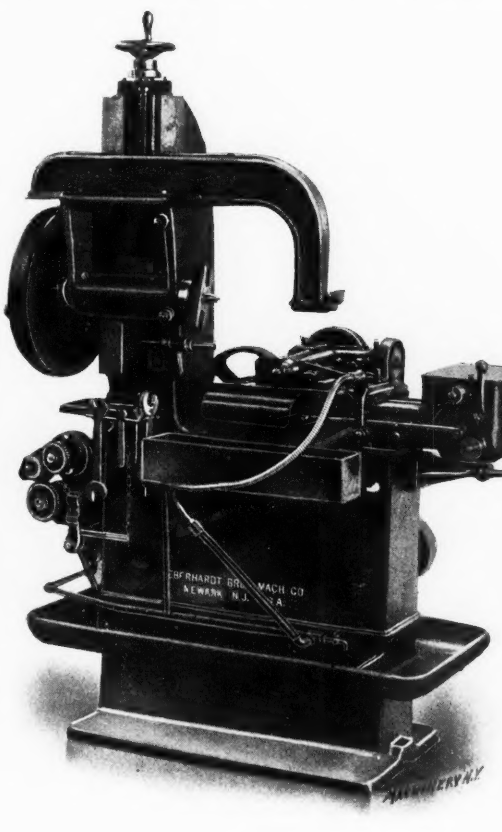


Fig. 1. Eberhardt Bros. Automatic Gear Cutter for Small and Medium Work.

teeth in its periphery. The slide can thus be tipped to any position up to 90 degrees, making the machine suitable for such work as milling face clutches, etc. In the front view in Fig. 1 will be noticed a slotted link which may be tightened to give additional stiffness to the slide, when it is set for any desired angular adjustment. The segment is graduated in degrees.

The indexing mechanism is positive, and operates through a master wheel of large diameter compared with the work, as will be seen from the cuts. An outboard support is provided for the work arbor, which is adjustable for different lengths of arbors, but is always centered accurately in line with the work spindle. This is especially convenient in a machine of this class, since it allows rapid setting. The cuts show a dog driver in place in the spindle, and a 60-degree center in the overhanging work support. These are furnished with the machine, and are useful in such work as milling flutes in taps and reamers, cutting gears on ordinary lathe mandrels, cutting pinions solid with the shaft, etc. The shank of this dog driver, like that for the various work arbors used, is drawn in to its

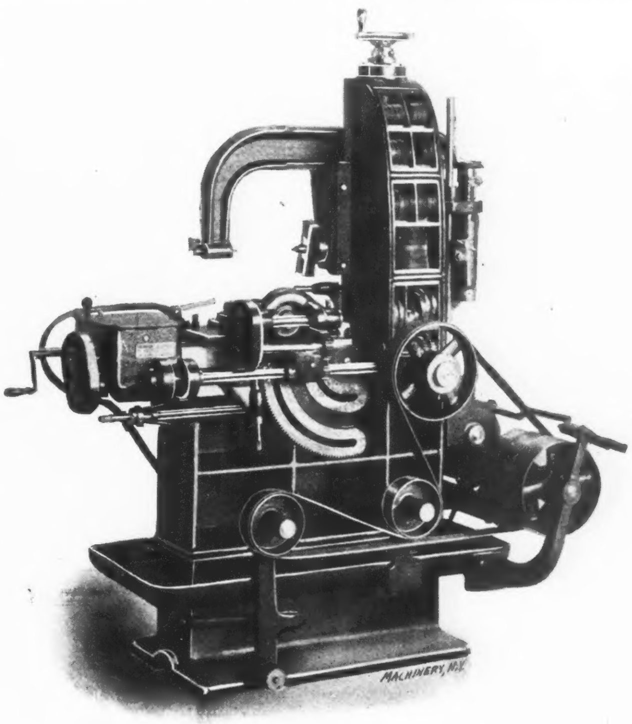


Fig. 2. Rear of Machine, snowing Provisions for Cutting Bevel Gears.

tapered seat or ejected, positively, by a bolt operated with a handle at the back of the work head. The taper of the work spindle hole is No. 10.

A screw is provided for adjusting, on a lower slide, the whole feed mechanism, cutter spindle and adjustable segment, toward or away from the column, to allow for different lengths of hubs. The dial, graduated to thousandths, facilitates this setting. Graduated dials are also provided on the indexing worm and on the cutter spindle bearing, for rolling the blank and shifting the cutter in cutting bevel and miter gears. The elevating screw for the work spindle has also a dial for showing the proper depth to be cut.

The chips are caught in a box in the side of the machine, where the oil is strained from them and is caught in an ample reservoir formed around the frame. The oil pump provided affords a constant stream of cutting lubricant, and it can be adjusted to regulate the supply.

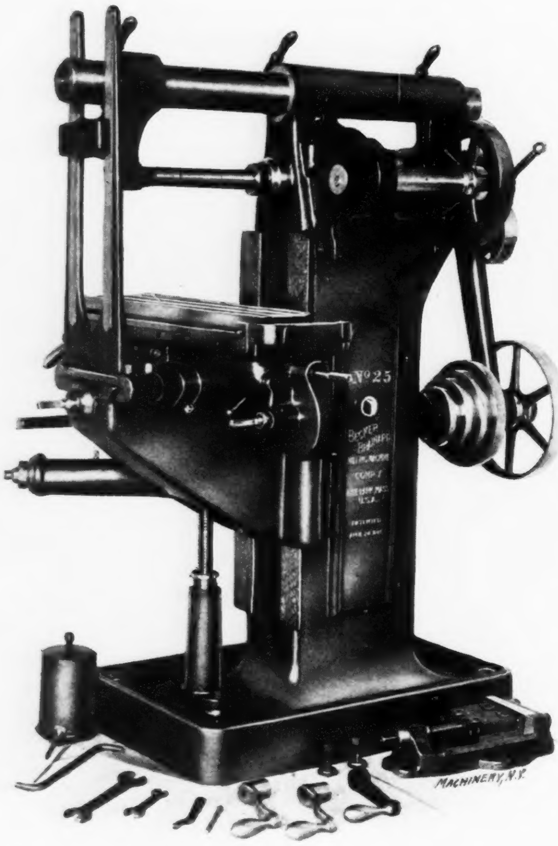
BECKER-BRAINARD PLAIN MILLING MACHINES FOR LIGHT MANUFACTURING.

The Becker-Brainard Milling Machine Co., of Hyde Park, Mass., has placed on the market two new machines adapted to meet the requirements of the manufacturer of small parts produced in large quantities—such work, for instance, as is to be found in small arms, typewriters, sewing machines, and electrical supplies. Two styles are made, one back geared and the other plain. The halftone shows the back-geared machine.

In bringing out the new model, special attention has been paid to the feed works. It is so designed as to be able to carry the full power of the feed belt, and at the same time stand up well under the rough usage to which machines engaged in manufacturing are subjected. The feed is driven by a belt from a pulley geared with the spindle of the machine, in such a way that the velocity of the belt is sufficient to drive feeds as heavy as the spindle drive will stand. The changes are obtained by a 4-step cone on the rear of the machine; the

pulleys may be interchanged so as to give a combination of eight feeds in all, ranging from 0.007 to 0.1 inch per revolution. The table is fed by a worm, meshing with a hobbed rack. The worm is driven by a worm gear of large size and a worm of coarse pitch, and correspondingly high efficiency. For disengaging the feed, a novel drop-worm mechanism is used, which obviates the difficulty met with in the old style gravity drop-worm, of clinging to the gear by friction alone. The worm is engaged and disengaged by the same lever, making the whole mechanism convenient and positive in its action. The table is also supplied with a quick return with a 4 to 1 ratio.

The new design has had the knee lengthened to permit the use of a front bracing of rigid construction, and still give the same range of cross adjustment as furnished with the older style machines. This bracing is of interesting design, being in the form of a single casting, clamped to the knee slide. To the arbor support yoke is fastened a clamp, so shaped as to permit it to swivel around its center, allowing the brace to



Milling Machine for Light Manufacturing.

be removed without entirely unscrewing any bolts at this point. This clamp is made fast to the brace by friction, giving a more rigid hold than the old style bolt, washer and slot arrangement, and at the same time allowing a much stiffer brace. The overhanging arm, which is a solid steel bar, is adjustable lengthwise, and the arbor support may be clamped on it at any convenient point.

These machines are equipped with a rigid box knee and with a telescopic elevating screw. The base has been designed along the same lines as the other Becker-Brainard millers, being heavy enough to absorb the vibration produced by the working of the cutters. The spindle cone and back gears are also of the firm's usual construction, the spindle bearing being cylindrical in form, with the wear taken up by concentric compensating bronze boxes. New patterns throughout have been made, and advantage has been taken of this opportunity to give the machine a neat and symmetrical appearance. All corners have been rounded and careful attention given to outlines, as may be seen in the cut.

These machines have a longitudinal feed of 34 inches, a cross-feed of 8 inches, and a vertical adjustment of 18 inches. The net weight is 1,650 pounds.

DOWNING UNIVERSAL BORING TOOL.

The tool shown in the accompanying line cuts is manufactured in three sizes by the Waco Machinery and Supply Co., Waco, Texas. It is interesting from the great completeness of adjustment provided by the design, permitting almost every condition of work to be satisfactorily performed. Bars of different sizes may be used for different sized holes; the extended length of the bar may be altered to agree with the depth of the hole; the point of the tool may be raised or lowered to bring it on the center line of the lathe; and even the top rake of the cutter may be changed to suit the material being worked on. These various adjustments are simply effected, as will be evident from the line cuts and the following description of the device.

Clamp *C*, which bears a general resemblance to a lathe dog, is provided with a T-head which enters the T-slot of the slide-

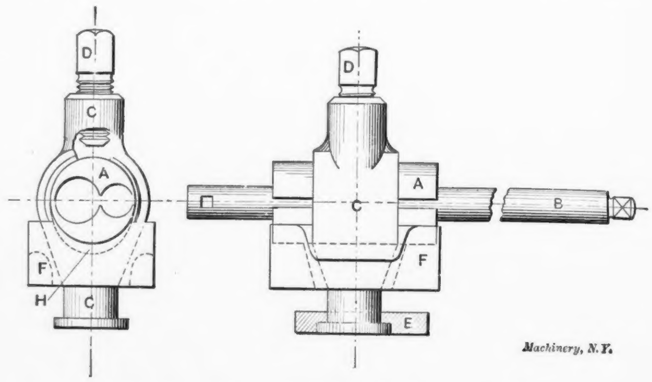


Fig. 1. Boring Tool and Holder, providing for Numerous Adjustments.

rest. A shoe, *E*, is furnished with the tool, which may be finished to fit the slot of any given lathe, thus making alterations in the clamp *C* unnecessary. Block *F* rests on the upper surface of the slide-rest, and has a hole through its center allowing clamp *C* to be passed through it. A bushing *A*, adapted to carry a boring bar of the desired size, passes through the opening in clamp *C*, and rests in a cylindrical seat in the top of block *F*. The lower side of the opening in the clamp is relieved as shown at *H*, so that when a boring bar, such as *B*, is in place in the bushing, and setscrew *D* is tightened down, the whole structure is clamped firmly together and to the slide-rest.

Bushings *A*, of which there are three, as shown in Fig. 2, have each two sizes of holes in them, so that boring bars of six different diameters are provided for. In the tool shown, these diameters are ¼, ½, ¾, 1, 1¼ and 1½ inch. The bar itself is shown at *B*. It is provided with two slots for holding the cutter, either at *L*, as shown by the full lines, or at *N*, as shown by the dotted lines. One position is useful in boring a

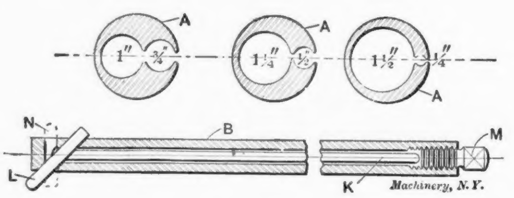


Fig. 2. Details of Boring Bar and Bushings.

blind hole, while the other is better suited for cases where there is clearance at the end of the cut. As shown, the bar is hollow. A setscrew, *M*, bearing on the end of rod *K*, clamps the blade firmly in its seat.

The manner of making the various adjustments described can now be readily followed. Any of the various sized bars furnished can be raised or lowered to the height of the center line of the lathe, by rocking in its seat, in block *F*, the bushing in which it is mounted. The bar may be adjusted for depth of hole by projecting it more or less from the bushing in which it is clamped. The top rake of the blade may be altered for different materials by rocking the bar in the hole of the bushing in which it is mounted to give an acute angle for babbitt, for instance, and a radial cut for brass.

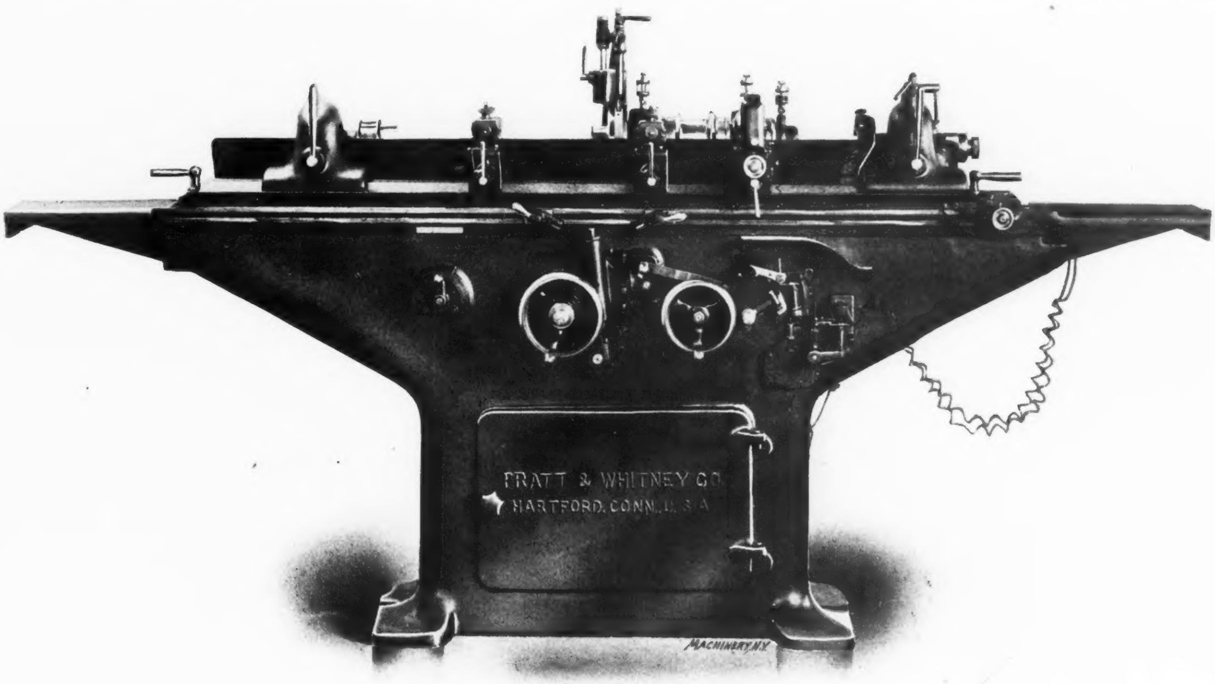
THE PRATT & WHITNEY AUTOMATIC GRINDING MACHINE.

The Pratt & Whitney Co., of Hartford, Conn., has designed and is marketing an automatic grinding machine, for cylindrical work up to 5 inches in diameter and 48 inches long. The word "automatic" can be applied to this grinder in a new sense. It does not mean simply the continuous reciprocation of the work table through a range determined by adjustment of the stops, and the provision for mechanically feeding in the emery wheel a definite amount at each stroke. Besides these usual provisions, this grinding machine has the novel feature of an automatic sizing attachment, which has been developed to such a point of practicality and efficiency that, as the builders say, "for the first time accurate grinding may be put into the hands of unskilled labor."

This remarkable function is performed electrically. An arm which rests upon the work being ground is set, with a micrometer screw, to make an electrical contact, when the work is down to the desired size. It does not matter how much the emery wheel wears, as the machine will keep on feeding until this electrical contact is obtained. At the first contact, the feed will switch off from coarse feed to fine feed. At the second contact, it will throw off the feed altogether. Thus it will be seen that work can be reduced very rapidly, as the feed can be adjusted to the limit that the work will stand, until the size has been nearly obtained, whereupon the machine automatically changes to a very fine feed, thus giving the work a smooth finish and exact size. If it is desired to grind only one or two pieces, where the setting of the sizing device would not pay in the opinion of the operator, the machine may be operated in the usual manner.

As to the general features of the machine, aside from the special improvement just described, the tool is a universal grinding machine of ingenious and practical design, and careful workmanship. The traverse of the table is operated by a rack and pinion, from a reversing mechanism driven by positive hardened clutches. The machine will reverse to within 0.001 inch, thereby making it possible to grind close to a shoulder. To facilitate changing the traverse speed of the table, as is often necessary, a feed changing mechanism giving three rates has been provided, changeable while the machine is in operation. It is operated by a crank handle at the front of the machine, shown in the cut at the left of the table traverse hand-wheel. The head and foot block are of very heavy construction. The pulley for rotating the work has dust-proof bearings. The machine is provided with two back rests of the most improved type, arranged (as are also the head- and foot-stock) to allow the use of convenient water guards for wet grinding. The water pump is of a new type, idlers for guiding the belt being dispensed with. A micrometer adjustment is provided for grinding tapers. This is so designed that it may be set by any one who can understand the reading of a micrometer caliper. If, for example, a taper of 1/8 inch per foot is desired, the micrometer will be turned 125 graduations.

The emery wheel is carried by a hardened and ground tool steel spindle, running in adjustable self aligning bronze boxes, mounted on a cross slide heavy enough to absorb all vibration. The weight is applied to the slide in such a way as to keep it constantly pressing hard against the feed screw, thus preventing the wheel from feeding forward except through the screw. The bed is cast in one piece and has a three-point bearing on the floor. All gearing and bearings are well protected from the dust, though so designed as to be accessible for examination and repairs.



Grinding Machine with Automatic Feed and Electrical Sizing Attachments.

NO. 4 LA POINTE BROACHING MACHINE.

The necessities of the automobile builder have resulted in a great increase in the amount and variety of work done by the broaching process. The use of squared shafts in the transmission case, and the general avoidance of keys and key-ways throughout the mechanism, result in having many parts formed with holes of other than circular section. Holes of this sort may be finished in various ways; they may be filed out tediously by hand to suitable gages, they may be finished on the slotting machine, or (the most rapid way of all) they may be "broached" at one stroke, with machinery and tools suitable for the purpose. The process of broaching consists in pulling through the opening to be formed a long blade having a series of teeth with the outline of the original hole at the inner end, gradually increasing in size and changing in shape until they have the outline of the completed hole at the further end. As such a tool as this is pulled through the work, each tooth removes a little metal, and the successive cuts thus taken complete the work as designed.

A machine much used for this purpose is the broaching machine built by the La Pointe Machine Tool Co. of Hudson, Mass. A great many of these are in daily operation, especially for wholesale key-way cutting. The same firm has recently extended its line of broaching machines to include a new No. 4 size, intended for longer and heavier work than their older machines. This tool is shown in Fig. 1. The broaching tool (used for simple key-seating in this case) is seen projecting from the front face of the machine. The

inner end or shank of this tool is grasped in a cross-head, sliding in the long guides extending forward from the head-stock. A slow inward cutting stroke can be given to this cross-head by means of the heavy screw shown connected to

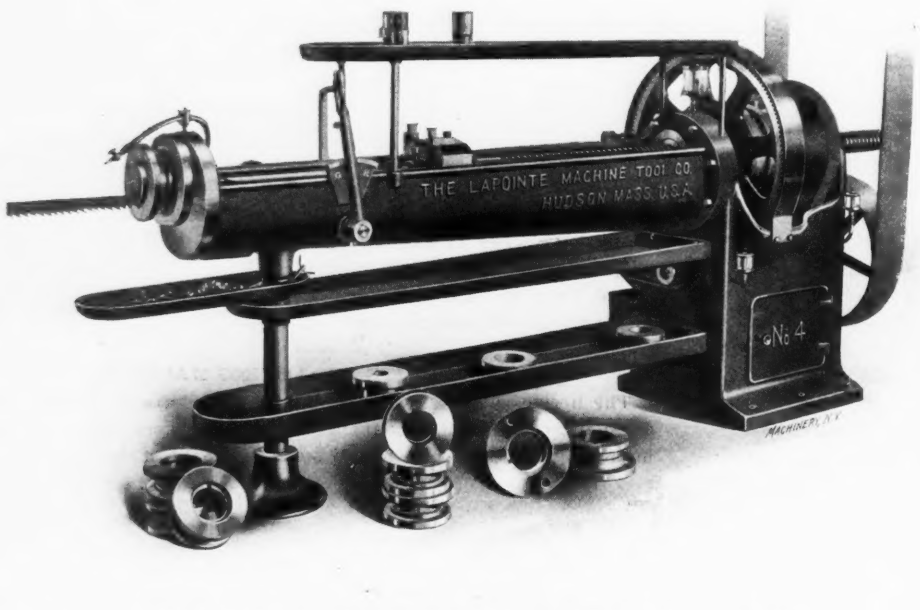


Fig. 1. Heavy Broaching Machine, especially adapted to Automobile Work.

it. This screw is threaded through a phosphor-bronze nut about 13 inches long, located between a driving gear and a friction pulley. The driving gear is rotated slowly with a speed reduction of 10 to 1, while the friction pulley has a rapid motion given to it. A clutch keyed to the bronze nut may be engaged with either the gear or the pulley, so that either a slow inward movement for the cutting stroke, or a rapid transverse in the other direction for a quick return, may be given to the head and its attached broach or cutter bar. This clutch is operated by the lever shown near the working end of the machine. Automatic stops are provided for the forward and backward motion of the head, the total travel of which is 70 inches. When the lever is in a vertical position, the clutch is entirely disengaged and the head and cutter bar are stationary. This mechanism is similar to that employed in the smaller machines previously referred to.

For cutting key-ways (the operation for which the tool is shown set up in Fig. 1), the cutter bar is run clear out and the work put on over it, and seated against the face-plate shown. This face-plate has a boss which fits the bore of the work to be key-seated, thus locating it with reference to the cutter bar. The machine is now started up for the cutting

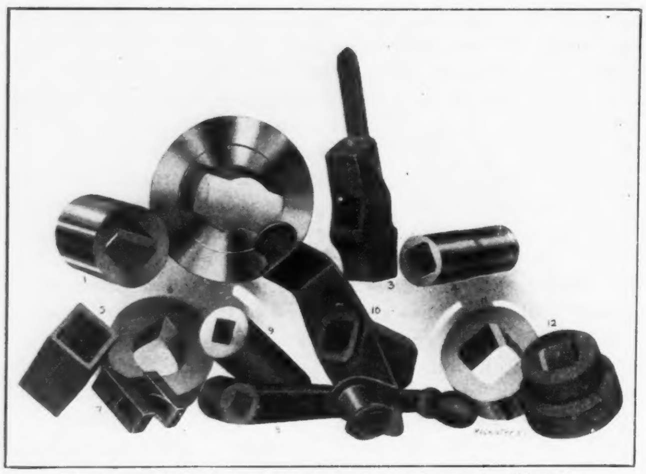


Fig. 2. Work Performed by the La Pointe Broaching Machine.

stroke. The teeth of the broach come in contact with the work one after the other, taking successively deeper cuts until the key-way is finished. For such work as square and oblong holes, etc., a clearance hole as large as possible has first to be drilled. The work is then put on the face-plate and the shank of the broach pushed through the clearance hole of the work, and grasped by the traveling head of the machine. The pulling through of the broach by the head completes the hole at one stroke. As before mentioned, it is not necessary to remove the cutter bar from the machine each time in the case of key-ways as it is with square holes, and several pieces may be finished at a time.

Some examples of work done on this line of machines are shown in Fig. 2. Piece No. 1, having a $1\frac{1}{2}$ inch square hole 3 inches long, was broached on a No. 3 machine with two operations in six minutes. Piece No. 2, made from a steel casting with $\frac{1}{8}$-inch stock all around in the cored hole, was finished at one stroke. The square holes in the gun chamber, No. 3, the wrench jaw, No. 7, the crank handle, No. 8, and the universal joint jaw, No. 10, were performed in from two to five minutes, the longest time being taken by piece No. 3. Piece No. 4, having a $1\frac{1}{4}$ inch square hole 5 inches long, was finished with three broaches in ten minutes. Part No. 11 was broached on a No. 3 machine at one stroke. The hole is $1\frac{3}{4}$ inch square and $1\frac{3}{4}$ inch long. Part No. 12 was broached in six minutes with two operations on a No. 3 machine. The hole is $1\frac{1}{2}$ inch square and $2\frac{1}{2}$ inches long.

The capacity of the No. 4 machine, shown in Fig. 1, is a 3-inch square hole 8 inches long, or a $1\frac{1}{4}$-inch key-way 14 inches long. In the cut this machine is shown broaching a $\frac{1}{2}$-inch key-way 5 inches long in a steel clutch. The time required for this was one minute.

YOST ELECTRICALLY-DRIVEN BENCH DRILL.

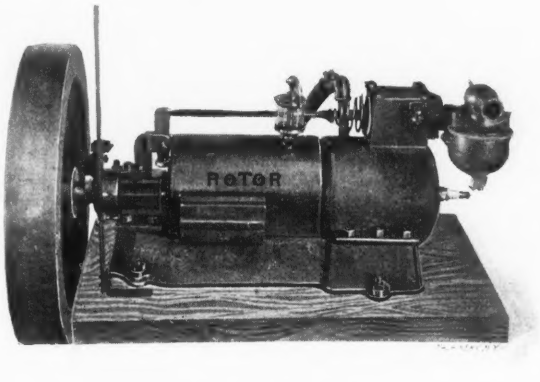
The little drill press shown in the cut is about as neat an arrangement for the purpose as could well be imagined. As shown, the motor is mounted directly above the spindle so that the armature drives the spindle itself, without the intermediation of gearing or belts. The spindle and sleeve are absolutely dust-proof. The thrust of the motor is taken by a ball bearing, and the shaft and spindle are hardened. The feed is very sensitive, and there is no vibration due to flying belts and unbalanced pulleys.

The motor gives a variation in speed from 800 to 3,000 revolutions per minute in 24 steps, thus enabling the operator to use the proper rate for all sizes of drills from 0 to $\frac{1}{4}$ inch. The motor is of the slow speed type, thoroughly ventilated; it can be brought instantly to any speed, stopped or started, without the inconvenience of shifting belts or friction gears. The capacity of the machine is for work up to 10 inches in diameter for a $\frac{1}{4}$-inch drill. The travel of the spindle is $2\frac{3}{4}$ inches. The motor is arranged to be directly connected to a 110- or 220-volt lighting circuit by the ordinary lamp socket. The whole outfit can be easily and quickly moved from one part of the shop to the other. The machine is built by the Faure Electrical Works, of Ossining, N. Y.

Yost Bench Drill.

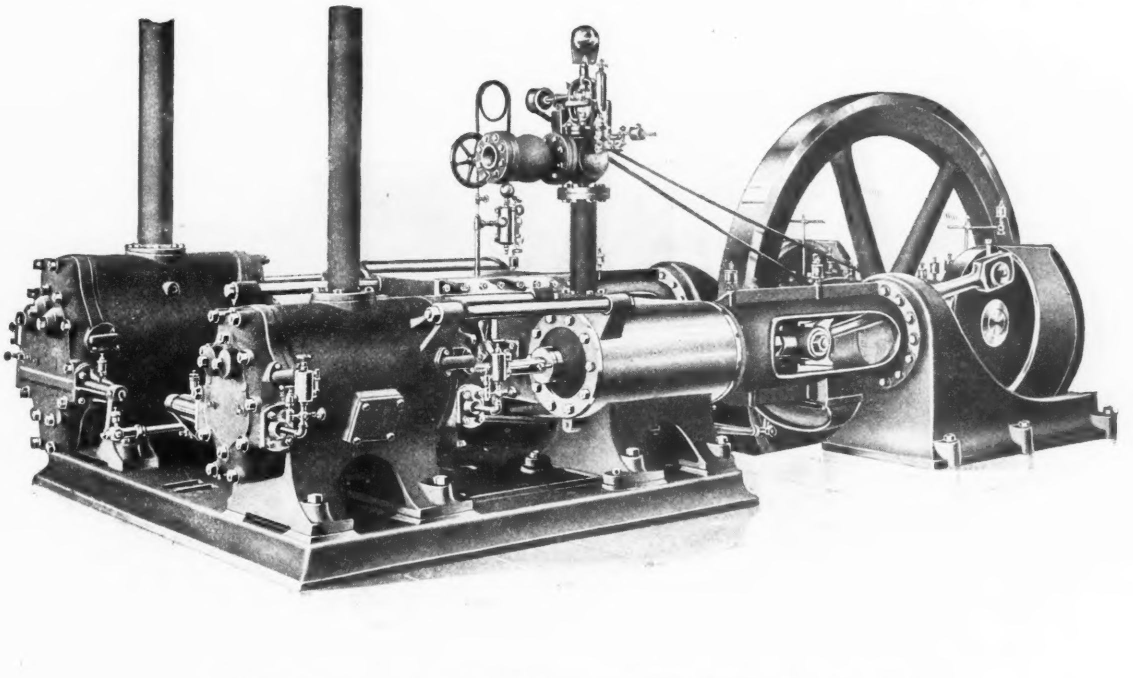
NOVEL TYPE OF GAS ENGINE.

The "Rotor" gas engine, made by the Central Machine & Metal Co., Moline, Ill., is built on a plan which, according to its builders, gives it distinct advantages over the ordinary connecting-rod and crank-driven engine. The machine shown in the cut is of the 5-horse-power size. The compactness of the design will be realized when it is stated that the base is 9 inches wide by 19 inches long, and that the total height of the engine is only 11 inches. The main peculiarity of the engine is the method used to convert the reciprocating motion of the piston into the rotary motion of the shaft. This is accomplished by a means that gives a nearly frictionless movement, all journals being of the roller or ball-bearing type. The construction may be extended to any desired number of cylinders, all in compact horizontal form. It has no geared parts, although it is of the four-cycle type. It may be readily reversed. Its small requirements as to floor space, and the direct power connections, with the tendency of the vibrating motion to be always lengthwise of the engine, give the "Rotor" engine design decided advantages for boat and automobile use.



The Rotor Gas Engine.

Among the other claims made by the manufacturers for this engine are, a gain due to the directness with which the power is applied to the shaft, a low fuel consumption, a quick air compression, and a thorough scavenging of the cylinder. Patents for this engine have been applied for.



Franklin Air Compressors, built for the Altoona Shops of the Pennsylvania Railroad.

FRANKLIN AIR COMPRESSORS.

The accompanying half-tone shows an air compressor built by the Chicago Pneumatic Tool Co., at their compressor works at Franklin, Pa. This machine is one of two installed in the power plant of the new South Altoona foundry of the Pennsylvania R. R. The machine is of the cross compound, two-stage air cylinder type, with separate intercoolers (not shown), and mechanically moved intake valves. The steam cylinders are 12 and 21 inches in diameter. The air cylinders are 11 and 19 inches respectively, with 24-inch stroke, designed for 100 pounds terminal air pressure with 125 pounds steam pressure. The machine has a piston displacement of 985 cubic feet of free air per minute, when making 125 turns per minute.

The frame of the machine is strongly built, following the approved lines of heavy Corliss engines. The air cylinders are tied to the steam cylinders by large tie-rods above and a heavy sole plate below, to which latter all four cylinders are fastened, as shown. The pillow blocks have unusually broad pedestals.

The air cylinders and cylinder heads are water-jacketed. The cooling effect is especially concentrated around the discharge valves, which naturally sustain the heat, due to the compression and friction, that has not been eliminated by the cylinder water jacket during the actual process of compression. To exclude the possibility of serious accident from the water which would enter the interior of the cylinder should the gasket between the cylinder and the head become damaged, an outside water connection is used for leading the water between the cylinder and the cylinder head. The steam valves are balanced slide valves, designed to give the greatest possible economy. In the machine shown the air intake valves are of the Corliss type, positively operated.

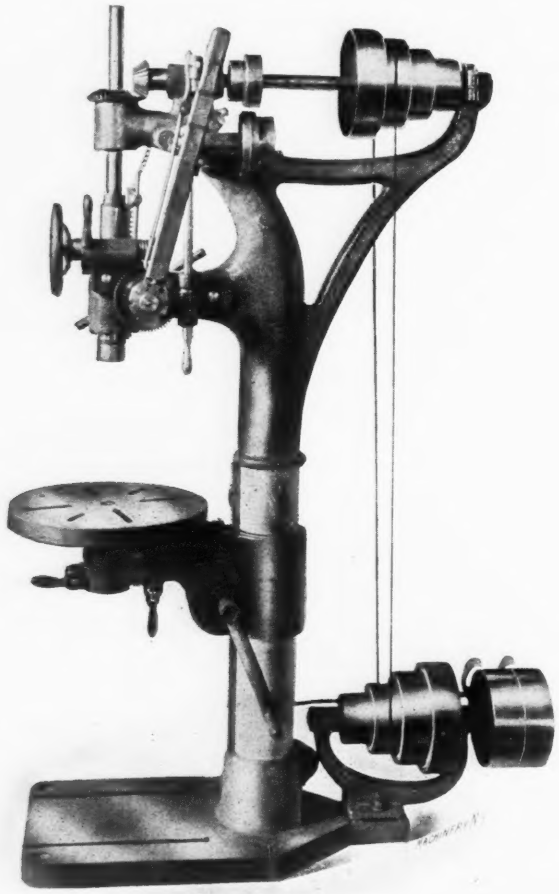
The cross-head, connecting-rod ends, bearings, etc., are built to agree with the most advanced steam engine practise. The shaft and crank-pins are forced to their places, the former being keyed and the latter riveted. The crank-pins are of special ground steel, while the crank-shafts are made from high grade steel forgings accurately turned and finished. The connecting-rods are of steel forgings finished all over, with adjustable boxes.

An intercooler, separate from the compressor so that it may be placed where convenience dictates, is a most important feature. It is of improved construction, allowing the interior to be cleaned readily. The tubes are made of a composition metal which does not rust or become foul. It is so constructed that the tubes are free to expand and contract without buckling and leaking.

Each compressor built by the Chicago Pneumatic Tool Co. undergoes before shipment a thorough working test. A special level testing floor of 15-inch I-beams is provided for this purpose in the Franklin plant. Even the largest compressors may be tried out at extreme load and maximum speed. All steam and air cylinders have indicator connections, and diagrams are taken under exact working conditions. These cards must show an efficiency equal to the established standard of the plant. A capacity test is also made to determine the actual

volume of compressed air delivered. Records of these tests are carefully filed and are always available for reference. A complete equipment of jigs and fixtures is provided for manufacturing these compressors, insuring absolute interchangeability, so that duplicate parts, whenever needed, may be sent for with full confidence that they will fit in their place.

The Chicago Pneumatic Tool Co. manufactures these Franklin air compressors in more than 100 sizes and styles, ranging in capacity from 30 to 5,000 cubic feet of free air per minute displacement, and suitable for a wide range of uses in addition to the operation of pneumatic shop appliances. Full information may be obtained from the company's offices in Chicago or New York, or from its branch offices in other cities.



Robertson Drill Press with Universal Table.

NO. 21 ROBERTSON UNIVERSAL DRILL PRESS.

One of the important features of the drill press manufactured by the Robertson Mfg. Co., Buffalo, N. Y., is the universal adjustment given to the drill table. As may be seen in the cut, the table can be rotated about a horizontal axis, thus making it possible to drill a hole at any angle with the surface by which the work is fastened down. The value of this feature has been demonstrated continuously in the plant of the builders in the past few years. It was originally designed to perform certain operations in their product, and proved to be such a success that they have decided to build a complete line of drill presses with this feature. Their long experience with it enables them to present it in practical form.

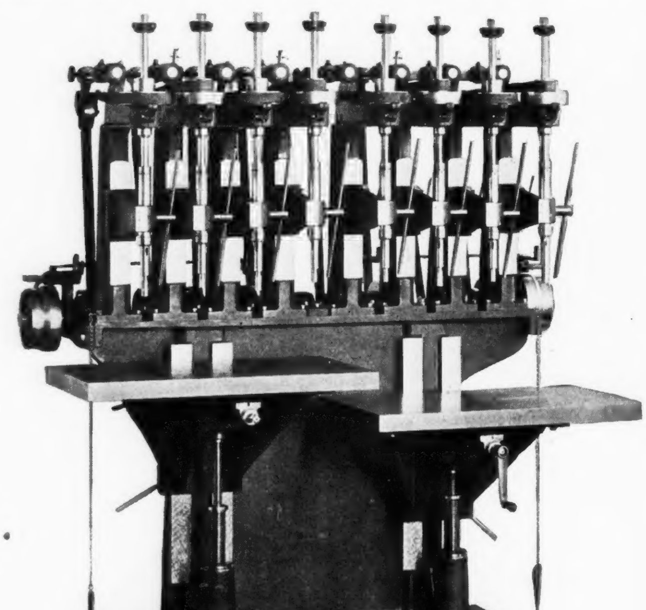
The knee is raised by a crank fitted to a steel shaft, with a pinion milled from the solid, meshing with a rack on the column. The rack is also of steel, with cut teeth. The universal joint for the work table is so designed as to give a rigid support to the table, with provision for drawing all bearings tightly together with the clamp screws shown. A lock bolt is provided for setting the table accurately in 45 and 90 degree positions. The spindle is of special high carbon steel, carefully fitted, with the thrust taken by fiber collars. The hole is a No. 3 Morse taper. The column is heavy and secured to the base by a clamping bolt. The base is provided with T-slots for clamping heavy work.

The machine may be provided in any of the following forms: With universal table or solid knee; with lever feed; with wheel and lever feed and quick return; wheel and lever feed, quick return, power feed, and automatic stop; it may also be furnished with or without back gears as desired. The bevel gears are planed from the solid metal and are provided with guards. The machine shown will drill to the center of a 42-inch circle.

1907 MODEL HENRY & WRIGHT DRILL PRESS.

The ingenious sensitive drill press invented by Mr. Chas. D. Rice, and built by the Henry & Wright Mfg. Co. of Hartford, Conn., was described in the November, 1904, issue of MACHINERY. As will be remembered, a number of novel ideas were incorporated in the design of this machine. Four speeds, for instance, are obtained from two-step pulleys. The machine is equipped with ball-bearings throughout, even for the loose pulley; a roller key arrangement is used to transmit the rotary motion from the spindle pulley to the spindle; and this pulley is supported entirely independently of the spindle, on ball bearings. The result of these various refinements is a machine as sensitive as the smallest, and yet able to drive with ease a ¾-inch drill with unusually small belts.

In the new model machine, of which an example is shown below, further improvements have been introduced to increase the efficiency of the drive and the handiness of operation. An entirely new spindle pulley construction has been used, which insures perfect alignment and confines the wear to the ball cases and the cones alone. When this spindle pulley is assembled with the driving blocks, ball cases, cones and balls, it may be handled as a complete unit, and may be placed in position in the frame, or removed at will by adjusting two screws in the bearing, provided for that purpose. The pillars in the new model have been enlarged, and are tapered from the top to the base to allow the use of a heavier weight for the quick return. The new shipper shown brings the handle to the nearest practicable point for the operator; the long multiple spindle drills are furnished with handles on both sides of the machine. By referring to the previous description, above referred to, it will be noted that one of the idlers is raised or lowered to shift the belt from one step to the other on the spindle pulley. In the new design this change is made by a bayonet catch, instead of by the thumb-screw formerly used. The weight of the castings throughout the machine has been increased to give greater rigidity, and all the spindles are furnished with 1¼-inch noses to give greater strength to spindle when large drills are used.



Henry & Wright Ball-bearing Multiple Spindle Drill.

The new model is made with from one to eight spindles, and

of from 7 to 15 inches overhang, so as to drill, if desired, to the center of a 30-inch circle. In the eight-spindle machine, as shown in the cut, the base is made in box form, to give the greater rigidity required in a machine of this character. Two tables are also provided, each with a heavy telescopic raising screw. This duplication of tables and raising screws allows the operator to work to advantage with oblong jigs. One of the tables may be raised to the proper height to support the jig when it is laid on its side, while the others may be adjusted to drill into the jig from the end. This machine also is provided with a separate tight and loose pulley for each of the spindles, so that eight speeds may be obtained, each suitable for the work it has to do. A small two-piece pulley may be clamped to the rear shaft, to give the proper speed for tapping.

THE WING STEAM-TURBINE-DRIVEN FAN.

Mr. L. J. Wing, president of the L. J. Wing Mfg. Co. of 90 West St., New York City, who is said to be the original inventor of the disk fan, has recently developed a novel combination of disk fan and steam turbine which is adaptable for a number of uses.

The construction, as may be imagined, is extremely simple. A rim is carried around the ends of the blades of a suitably designed disk fan, tying them together and being supported by them. To this rim is fastened a set of carefully designed turbine buckets, against which jets of steam are directed from two or more suitably disposed nozzles. There is but one rotating shaft, and practically but one rotating member, the turbine, buckets, rim, fan and its shaft all revolving as one piece in double ball-bearings.

The design of the nozzles, buckets and fan, has been the subject of careful study and experiment, and a high degree of efficiency has been attained. The simplicity of the arrangement will be at once appreciated when a fan of this kind is compared with one of the same capacity driven by a steam engine, mounted in a suitable housing and supported on the required foundations. No exhaust piping is required, since the steam after imparting its energy to the wheel passes along with the delivered air. The only attention or care required is the lubrication of the ball bearings, once a month or thereabouts, with vaseline or other suitable compound.

A use for which this outfit is especially adapted is in producing forced draft for boilers. For this work it is usually set into the side or rear wall of the boiler just below the grates. Such an arrangement has all the advantages of simplicity, low first cost, and ease of maintenance.

A TIME AND COST COMPUTER.

At the Railway Master Mechanics' Convention at Atlantic City, the Bullard Machine Tool Co. distributed to the members an ingenious and very useful souvenir in the form of a time and cost computer. This is a circular slide rule, designed by Mr. William Cox, of New York, who has had considerable experience in this line. It consists of cardboard sectors which may be revolved about a central pivot to bring the various graduations on the peripheries in line with each other. By following the directions given, various problems relating to time and cost may be solved, such as the following: To find the time required for turning or boring when the cutting speed, feed, diameter of work and length of cut are known; to find the approximate time required for facing when the diameter, length of cut, cutting speed and feed are known; to find suitable cutting speed and feed when the dimensions of the piece are known, and the time required has been fixed. To find the cost when the rate per hour and time to do the work are known. The instrument and the directions are enclosed in a handsome leather case which fits the pocket.

* * *

Eggs are ordinarily regarded as very fragile, but proportionately to its weight an egg shell is very strong. The "egg test" so much used in trying elevator safety stops is, therefore, deceiving. An egg may not break when subjected to the stopping test in an elevator with an impact that would be disastrous to a human being, and which, in fact, might break nearly every bone in his body.

INDUSTRIAL NOTES FROM EUROPE.

BRITISH TRADE TOPICS.

The trend of British industrial development is still upward. Considerable efforts have been made during the last few years to have the fiscal system of the country—practically universal free trade—altered in such manner as to have a protective effect on certain industries; but these efforts have shown but little practical result. The current Board of Trade returns indicate such an enormous volume of trade that hesitation is naturally shown to interference with methods so remarkably successful. For instance, the imports into Great Britain during the month of April represent a total value of $283,930,485, an increase of $48,633,935 over the figures for the corresponding period in last year, and the exports were valued at $172,084,330, and are $36,922,800 in advance of the total for April, 1906. For the first four months of the present year the imports were valued at $1,139,805,460, an improvement of $133,419,270, and the exports for the same term with a total of $681,419,260 were $90,272,250 ahead of last year's corresponding returns. The manufacture of iron and steel stood at $20,493,155, an increase during the month under consideration of $5,121,515. Machinery comes fourth among the classified exports with $13,096,010, an increase of $2,330,915. Textile machinery was imported to the value of $90,470 during the month. This was nearly $50,000 in advance of the same period last year. The exports of this class of machinery during April were $3,142,465, as against $2,639,640 in the corresponding portion of 1906.

A specific instance of the effect of free trade is in evidence in the case of the silk and felt hat industry, which is enjoying a period of unexampled prosperity due to the manufacturers obtaining their raw material distinctly cheaper than any of their competitors. This activity is, of course, reflected to some degree on the machinists, catering specially to this industry.

The Shipbuilding Industry.

Prices of materials for engineering industries remain very stiff. All British brands of pig iron are in great demand both on home and export account. Shipbuilding on the northeast coast and the Clyde has received an impetus during the last month or so in the way of additional orders, though conditions were not at all unfavorable previously. Messrs. Yarrow & Co., Ltd., the well-known torpedo-boat builders, who are removing from the Thames to escape the unfavorable local conditions, are having new works erected at Glasgow by Sir Wm. Arrol & Co. The present portion now under erection has a length of 248 feet, and three bays of an aggregate width of 153 feet. The boiler shop is 303 feet long with three bays totaling 153 feet wide. Adjoining, the same builders are putting up workshops for the Coventry Ordnance Works, Ltd. Both have a length of 675 feet and a total width of 134 feet, the height being 63 feet. Considerable interest is being evinced in the manufacture of motor boats, which are now built for quite a variety of commercial inland and coasting services, in addition to the pleasure types of craft, which were at first mostly considered.

Federations and Unions.

Federation of kindred groups of trade, is becoming increasingly in evidence on the part of both employers and workmen. The latest instance is in the case of the operative iron and brass founders, where a number of sectional trade unions have arrived at a common understanding, and are formulating governing regulations. These societies include molding machine hands, brass founders, coremakers, etc., as well as the orthodox iron molders. On the northeast coast discussion is proceeding as to the organization of the plating squads employed in the steel shipbuilding trade. It is claimed by the employers that the basis of demarkation of work among the men is out of touch with modern requirements, and gives an advantage to other competing districts, which work under more flexible conditions.

In the automobile industry steps are being taken to standardize specifications of material and generally used details, and to lay down a common basis on many points which, more

or less loosely defined, militate against cheap production. Considerable attention is also being given to the training of junior aspirants to membership of the institution specially concerned with this branch of engineering, special facilities being provided for this purpose.

Building and Civil Engineering.

The recent Building Trades Exhibition at Olympia, London, was very successful and demonstrated the increasing interdependence of the building and engineering trades. Methods used in British building practice are being considerably influenced by American ideas of preparing concrete, asphalt, etc., by machinery, which is obtaining an increasing hold.

An indirect result of the carrying out by British contractors in Egypt of important civil engineering works, is the training thereby afforded to large numbers of natives. The bulk of the labor employed has been local, and it has been found that under the supervision of British instructors and foremen the natives have done very creditable work. This feature has been specially marked in the case of the erection of steel structures.

Gas Engines.

On behalf of the Institute of Mechanical Engineers, Prof. Burstall, of Birmingham University, is conducting a series of tests and experiments on the thermal efficiency of gas engines. It is understood that some remarkable results have been obtained, and the publication of the general conclusions arrived at, in a special report to the Institute, is anticipated with considerable interest by gas engine builders and engineers generally. Gas engines, in what were not long ago considered as unwieldy sizes and powers, are coming into increasing use. Their employment varies from blast furnace and steel works duty to the running of cotton mills and vessels for inland traffic. Several concerns which build large steam engines, turbines, etc., now manufacture gas engines also. Among these may be mentioned Mather & Platt, Ltd., and the British Westinghouse Co., Manchester. Messrs. Beardmore & Co., Ltd., Glasgow, also build large gas engines to work with blast furnace gases.

Shop Topics—Machine Tools.

Machine men—those working drills, planers, milling and gear cutting, and grinding machines, etc.—are becoming better recognized in this country than formerly. To obtain really good results from modern machines, on a profitable interchangeable basis, requires in many instances high skill, and in others such consistent carefulness and application, that employers find it expedient more frankly to appreciate—in the direction of the pay box—such services; while the easily identified types of skilled engineer journeymen find their work and that of the machine men more closely merged than ever before. When advertising, too, much has sometimes been made of the "automatic" characteristics of their machines by builders, with the result that neither the tools nor the men manipulating them have received their due meed of respect. Though machine tools to a very considerably value have during the last number of years been imported from America by Great Britain, the reciprocal process has been on a comparatively small scale, though on the Pacific coast the heavier British tools appear more in evidence than in other sections of the United States. This state of things is probably due, to a great extent, to the heavy duties exacted on machinery entering the United States. There are signs, however, of some little change of attitude, as we have heard during the last year or two of a very fair number of British tools being sold on American account. There is little doubt that the duties tend to establish a greater degree of insularity on the part of Americans than even the Britishers have in the past been credited—or charged—with. Over here machine tools of British, American, and Continental origin work cheek by jowl, and a broader and less partial estimate of their relative merits can be made than in perhaps any other country. In conjunction with the above mentioned tendency, the fact must also be taken into consideration that British importers of machine tools are increasingly manufacturing tools on their own account, either in their own workshops or by contracting with other British shops. The manufacture of accessories of small and medium dimensions has also greatly increased in the last few years. The introduction of high-speed steel, which after being introduced to Europe from America at the Paris Exposition of 1900, has since mainly been manufactured here, has largely contributed to this position. High-speed twist drills, in particular, are manufactured by a surprisingly large number of concerns, who, though not much in evidence in the technical press, contrive to do a very respectable business. Though the American output may be larger than ever, it is evident that transatlantic producers have missed this development. Several details of machine tool construction appear to be rapidly becoming less prominently identified with British or American practise respectively. Such instances as lathes having flat grinding surfaces, or raised V-s on the ways of the bed, gap lathe beds—fixed or adjustable—single or 4-stud lathe tool holders, friction-driven countershafts, etc., which were formerly quite distinctive features, cannot now, in themselves, be taken to indicate the origin of a machine tool. This interchange is probably "all to the good."

Henry Pels, Strand, London, has within the last five or six years introduced a number of punching and shearing machines of Continental origin into this country. They are mainly intended for use on constructional steel work, and vary from hand-worked machines to motor-driven examples of considerable power. Their main features are that the framing of all the types is built up of mild steel plates riveted together, so that a machine for any standard or special duty can be quickly made up without the necessity of pattern making, and that the stroke of the tools is produced by cam movements worked by ratchets, the movements being extremely small but rapid. The hand-worked machines cover a surpisingly large range of work. In this country Geo. Richards & Co., Ltd., Broadheath, have largely identified themselves with the open side, or traveling tool, type of metal planing machines, and have recently produced several machines for special applications of the feature. In one, the overhanging arm carrying the tool box can be inclined at an angle for planing diagonally. In another the ordinary arm can be removed and a vertical one substituted. We hope later to give some further details and illustrations of these machines. JAMES VOSE.

Manchester, England, June 1, 1907.

MISCELLANEOUS FOREIGN NOTES.

ANDREW BARCLAY, SONS, & CO., LTD., Kilmarnock, Scotland, builders of locomotives and railway motor cars of all types, being one of the two leading firms in Scotland in this industry, have recently completed considerable extensions to their works.

EXPOSITION OF SAFETY DEVICES IN BUDAPEST.—According to *Industritidningen Norden*, there will be held at Budapest, during the months of August, September and October this year, an international exposition for safety devices. Inquiries regarding this exposition should be addressed to the Bureau of the Exposition, Balvamyutca 2, Budapest, Hungary.

MACHINE TOOL OUTLOOK IN SPAIN.—Consular reports from Spain indicate that the demand for high-class American machine tools is steadily increasing in that country. Although there are no exact statistics, it is likely that at least $200,000 worth of these tools were exported to Spain from the United States during 1906. The automobile industry is prosperous and growing in Spain, and machines for automobile manufacturing are in demand.

MACHINE TOOLS IN TURKEY.—Consul Ernest L. Harris, of Smyrna, reports that lathes, planers, drill presses and small tools are in demand. Milling machines are not so commonly used. The British manufacturers are mainly supplying the trade, but there are no reasons why American manufacturers should not here have an important opportunity, because American machine tools, whenever imported to the country, have given the best satisfaction. Of lathes, the gap lathe style is most highly in favor.

THE ITALIAN TARIFF.—Italy probably has the distinction of being, next to the United States, the most highly tariff-protected country in the world. At the present time there is,

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PROVIDENCE, R. I., U. S. A.

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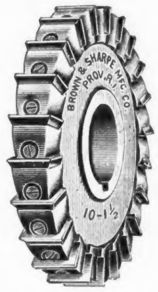
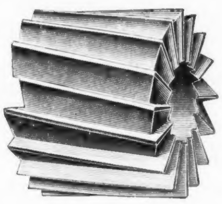


may enable you to choose a Cutter of the proper style and size. But do you get the Cutter that combines correctness in design with the highest quality of material and workmanship; **in other words the Right Cutter for the job?**



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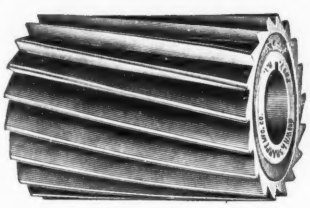
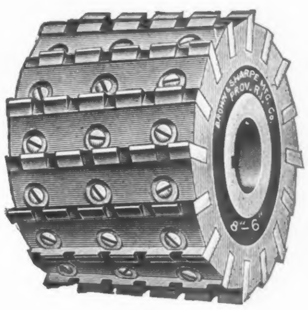




Cutter List sent to any address upon application.

according to the *Rassegna Mineraria*, a movement on foot for the removal of the tariff on rolled iron plates and tubes. It is likely that unless something is done to promote the trade of Italy with foreign countries through the removal of the tariff, at least in certain respects, it will prove disastrous to the industrial revival of the country. The steel interests of the country are, of course, up in arms against such a proposition, they being the only ones who benefit by the high tariff.

GREENWOOD & BATLEY, LTD., Leeds, England, have recently put on the market an improved vertical mortise drilling machine. This machine is furnished either motor- or belt-driven. The table is 5 feet long by 9 inches wide, and has 3 T-grooves. The vertical adjustment of the spindle is 13 inches, and the maximum distance from the spindle nose to the top of the table is 17½ inches. The spindle speeds are 70, 100, and 140 revolutions per minute. The drill is of a particularly rigid construction and all feed motions are arranged both for automatic and hand feed.

THE LOW MOOR CO., LTD., Bradford, England, have added a new small-sized motor-driven boring and turning mill to their line of machines. The diameter of the table is 4 feet, and this is also the limit of the diameter of the work. The machine is particularly intended for turning and boring pistons, cylinder covers, pulleys and small flywheels. The motor is carried on an extension of the main frame at the back and has variations in speed from 300 to 900 revolutions per minute, which, together with the gearing, gives variations from 1.25 to 37.5 revolutions per minute to the table. The machine admits work 3 feet 3 inches high under the tool-holders.

TRADE CONDITIONS IN ITALY.—Consul A. H. Michelson, Turin, Italy, reports that the great wave of industrial activity which has swept over Italy during the past five years has made itself particularly felt in the development of the automobile industry, and that eleven new companies for the manufacture of automobiles were founded in Turin during 1906, and nine in 1905, there being in all twenty-three companies manufacturing automobiles in that city. The consul calls the attention of American manufacturers who are in a position to place machine tools, as well as certain automobile accessories, in the Italian market, to the present prosperous conditions and the industrial activity of Turin.

THE PRESENT STATE OF FRENCH INDUSTRIES.—Consul Hilary S. Brunot reports to the Department of Commerce and Labor that the past year has been one of continued prosperity in France. Factories of all kinds have been working full time; many have been working two shifts, and still have had difficulty in keeping pace with the demands. The prices for raw materials as well as for manufactured products have increased. The automobile and bicycle industries are particularly busy, and there is a great demand for special machinery for the manufacture of motor cars. Judging from the consul's report, there is at the present time an unequaled opening in France for firms manufacturing machine tools and small tools, and particularly for those willing to make automatic machinery to order.

* * *

OBITUARY.

John A. Lang, secretary and treasurer of the Williams Tool Co., Erie, Pa., died of valvular disease of the heart, May 28, at his home in that city. He was born in Baltimore, Md., 1856. He had been a resident of Erie for twenty-two years, and was highly respected by friends and employes. The Williams Tool Co. was organized six years ago by Mr. Lang, R. T. McClure, T. W. Shacklett, J. C. Williams, and John Jordan, Jr. Mr. Lang leaves a wife and three children.

ALBERT P. SIBLEY.

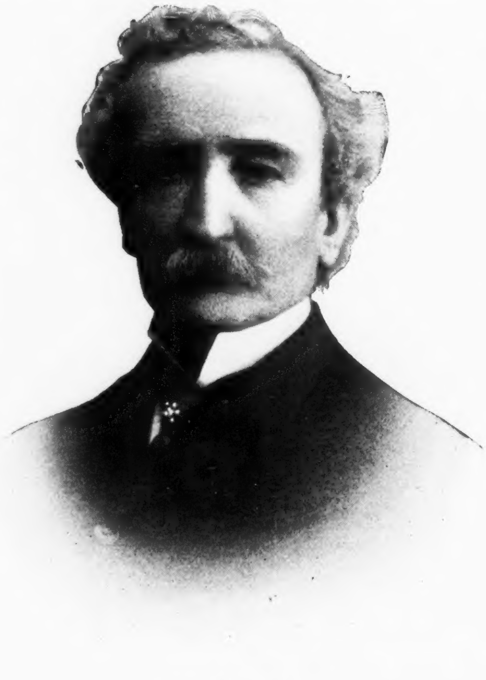
Albert P. Sibley, president, treasurer and general manager of the Sibley Machine Tool Co., South Bend, Indiana, died May 25. Mr. Sibley was born at Spencer, Mass., in 1847, and at the age of nineteen entered the shops of L. W. Pond, Worcester, Mass., as an apprentice at the machinist's trade, where he worked until 1873. While at Pond's he had a contract for making power drills, and upon leaving this place he went

Albert P. Sibley.

West with J. R. Mills, to start a machine business. He located at South Bend, Indiana, where Mr. George O. Ware joined them later. The firm eventually became Sibley & Ware. Mr. Ware died April 19 of this year, the firm then becoming the Sibley Machine Tool Co. Mr. Sibley leaves a wife and three children. His death is deeply regretted in the town where he was one of its leading citizens. He had built up a substantial manufacturing business, and the product of the company is favorably known. The business will be conducted without interruption.

JOHN A. WALKER.

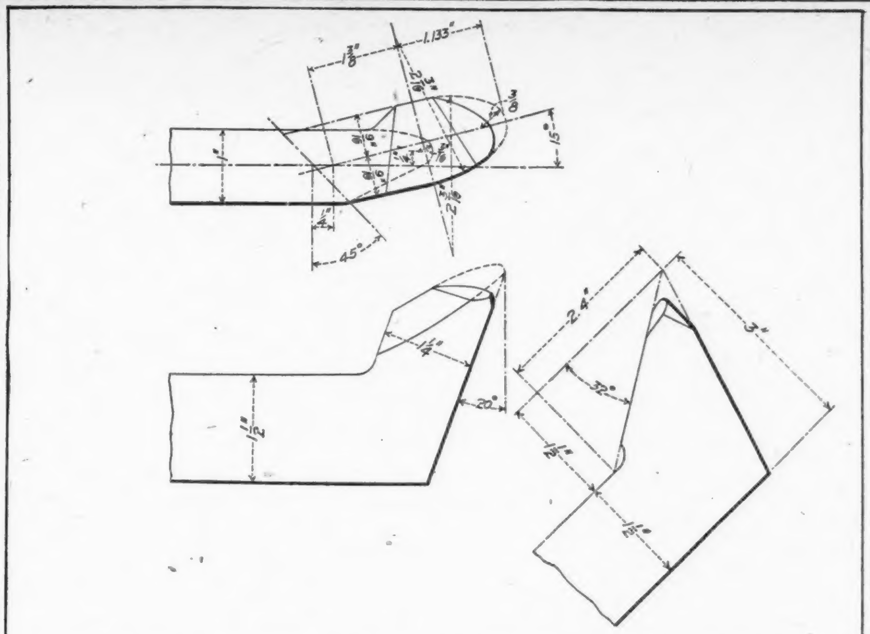
John A. Walker, vice-president and treasurer of the Joseph Dixon Crucible Co., died at his home in Jersey City, on May 23, after an illness of about one month. Mr. Walker was born of Scotch parentage in New York, September 22, 1837. He was



John A. Walker.

educated in the schools of Brooklyn, and although prepared for college, chose commercial life. He served as a soldier in the Civil War, and in 1867 became connected with the firm of Joseph Dixon & Co. In 1868, when the company was incorporated, he was made secretary, and acted in this capacity, and largely that of manager as well, until 1891, when he was elected vice-president and treasurer, which position he held until the time of his death. Mr. Walker was an energetic man

LATHE CUTTING SPEEDS, STEEL.—I.



Detailed Dimensions of 1-inch Round Nose Roughing Tool. Forged Outline shown by Dotted Lines and Ground Form by Full Lines. Clearance, 6 degrees; Back slope, 8 degrees, and Side Slope 14 degrees.

Standard 1¼ inch Tool

Cutting Speed, in feet per minute for a tool which is to last 1 hour and 30 minutes before regrinding

Depth of Cut in Inches	Feed in Inches	Soft Steel	Medium Steel	Hard Steel
3/32	1/64	518	259	118
3/32	1/32	366	183	83.2
	1/16	257	129	58.4
	3/32	209	105	47.5
1/8	1/64	450	225	102
	1/32	317	158	72.0
	1/16	223	112	50.7
	3/32	182	90.8	41.4
	1/8	157	78.5	35.7
3/16	1/64	370	185	84.1
	1/32	260	130	59.1
	1/16	183	91.7	41.6
	3/32	149	74.6	33.8
	1/8	129	64.5	29.3
	3/16	105	52.6	23.8
1/4	1/64	322	161	73.2
	1/32	227	113	51.6
	1/16	159	79.7	36.1
	3/32	130	65.0	29.5
	1/8	.112	56.1	25.5
	3/16	91.4	45.7	20.8
3/8	1/64	264	132	60.0
	1/32	186	93.1	42.3
	1/16	131	65.5	29.8
	3/32	107	53.4	24.1
	1/8	92.2	46.1	20.8
1/2	1/64	230	115	52.3
	1/32	162	80.9	36.8
	1/16	114	56.9	25.9
	3/32	92.6	46.3	21.0

Standard 1 inch Tool

Depth of Cut in Inches	Feed in Inches	Soft Steel	Medium Steel	Hard Steel
3/32	1/64	490	245	111
	1/32	339	169	77.0
	1/16	235	117	53.4
	3/32	189	94.5	43.0
1/8	1/64	427	214	97.0
	1/32	296	148	67.2
	1/16	205	102	46.6
	3/32	165	83.0	37.5
	1/8	142	71.0	32.3
3/16	1/64	358	179	81.3
	1/32	247	124	56.1

Fred W. Taylor, Proceedings of A. S. M. E., December, 1906.

LATHE CUTTING SPEEDS, STEEL.—II.

Standard 1 inch Tool (Continued)

Cutting Speed in feet per minute for a tool which is to last 1 hour and 30 minutes before regrinding

Depth of Cut in Inches	Feed in Inches	Soft Steel	Medium Steel	Hard Steel
3/16	1/16	171	85.5	38.8
	3/32	138	69.0	31.3
	1/8	118	59.0	26.8
	3/16	95.0	47.5	21.6
1/4	1/64	315	157	71.6
	1/32	218	109	49.5
	1/16	150	75.0	34.1
	3/32	121	60.5	27.5
	1/8	104	52.0	23.6
3/8	1/64	263	132	59.8
	1/32	182	91.0	41.4
	1/16	126	62.8	28.5
	3/32	101	50.6	23.0
1/2	1/64	232	116	52.7
	1/32	161	80.5	36.6
	1/16	111	55.7	25.3

Standard 7/8 inch Tool

Depth of Cut in Inches	Feed in Inches	Soft Steel	Medium Steel	Hard Steel
3/32	1/64	476	238	108
	1/32	325	162	73.8
	1/16	222	111	50.4
	3/32	177	88.4	40.2
1/8	1/64	420	210	95.5
	1/32	286	143	65.0
	1/16	195	97.6	44.4
	3/32	156	77.9	35.4
	1/8	133	66.4	30.2

Standard 7/8 inch Tool (continued from first column)

Depth of Cut in Inches	Feed in Inches	Soft Steel	Medium Steel	Hard Steel
3/16	1/64	352	176	80.0
	1/32	240	120	54.5
	1/16	164	82	37.3
	3/32	131	65.5	29.8
	1/8	112	56.0	25.5
1/4	1/64	312	156	70.9
	1/32	213	107	48.4
	1/16	145	72.6	33.0
	3/32	116	58.1	26.4
3/8	1/64	264	132	60.0
	1/32	180	90.2	41.0
	1/16	122	61.1	27.8
1/2	1/64	237	118	53.8
	1/32	162	80.8	36.7

Standard ¾ inch Tool

Depth of Cut in Inches	Feed in Inches	Soft Steel	Medium Steel	Hard Steel
3/32	1/64	482	241	110
	1/32	323	161	73.4
	1/16	217	108	49.3
	3/32	172	85.8	39.0
1/8	1/64	423	212	96.1
	1/32	284	142	64.5
	1/16	190	95.2	43.2
	3/32	151	75.3	34.2
	1/8	128	63.8	29.0
3/16	1/64	358	179	81.4
	1/32	240	120	54.5
	1/16	161	80.5	36.6
	3/32	127	63.7	28.7
1/4	1/64	320	160	72.7
	1/32	215	107	48.8
	1/16	144	72	32.7
3/8	1/64	276	138	62.7
	1/32	185	92.4	42.0

Standard 5/8 inch Tool

Depth of Cut in Inches	Feed in Inches	Soft Steel	Medium Steel	Hard Steel
1/16	1/64	548	274	125
	1/32	358	179	81.6
	1/16	235	117	53.3
3/32	1/64	467	234	106
	1/32	306	153	69.5
	1/16	200	100	45.5
	3/32	156	78.0	35.5
1/8	1/64	417	209	94.8
	1/32	273	136	62.0
	1/16	179	89.3	40.6
	3/32	140	69.8	31.7
3/16	1/64	362	181	82.2
	1/32	236	118	53.8
	1/16	155	77.4	35.2
1/4	1/64	328	164	74.5
	1/32	215	107	48.8
3/8	1/64	286	143	65.0

Standard ½ inch Tool

Depth of Cut in Inches	Feed in Inches	Soft Steel	Medium Steel	Hard Steel
1/16	1/64	510	255	116
	1/32	322	161	73.2
	1/16	203	102	46.2
3/32	1/64	445	223	101
	1/32	281	141	63.9
	1/16	177	88.7	40.2
	3/32	135	67.4	30.7
1/8	1/64	404	202	91.8
	1/32	255	128	57.9
	1/16	161	81	36.6
3/16	1/64	359	179	81.6
	1/32	226	113	51.4
1/4	1/64	330	165	25.0

Fred W. Taylor, Proceedings of A. S. M. E., December, 1906.

This data sheet is made up so as to be readily bound. It may be cut into four sections, 6x9 inches in size, and bound into note-book form for convenient reference, by means of staples inserted into holes punched at points indicated.

PUNCH O

CREASE HERE

PUNCH O

LATHE CUTTING SPEEDS, CAST IRON.—I.

Cutting Speed, in feet per minute for a tool which is to last 1 hour and 30 minutes before regrinding

Standard 1 1/4 inch Tool

Depth of Cut in Inches	Feed in Inches	Soft Cast Iron	Medium Cast Iron	Hard Cast Iron
3/32	1/64	239	119.6	69.8
	1/32	191	95.3	55.6
	1/16	142	70.8	41.3
	3/32	118	59.1	34.4
	1/8	103	51.1	30.2
	3/16	85.0	42.5	24.8
1/8	1/64	216	108	63.1
	1/32	172	86.2	50.3
	1/16	128	64.0	37.3
	3/32	107	53.4	31.2
	1/8	93.4	46.7	27.3
	3/16	76.8	38.4	22.4
3/16	1/64	187	93.5	54.6
	1/32	149	74.6	43.6
	1/16	111	55.5	32.7
	3/32	92.5	46.3	27.0
	1/8	73.1	36.5	21.3
	3/16	66.4	33.2	19.4
1/4	1/64	168	84.1	49.1
	1/32	134	67.2	39.2
	1/16	99.8	49.9	29.1
	3/32	83.2	41.6	24.3
	1/8	72.6	36.3	21.2
	3/16	59.7	29.8	17.4
3/8	1/64	144	71.8	41.9
	1/32	115	57.3	33.4
	1/16	85.1	42.6	24.8
	3/32	70.9	35.5	20.7
	1/8	62.0	31.0	18.1
	3/16	51.0	25.5	14.9
1/2	1/64	131	55.6	38.3
	1/32	105	52.3	30.5
	1/16	77.6	38.8	22.7
	3/32	64.7	32.4	18.9
	1/8	56.6	28.3	16.5
	3/16	46.5	23.3	13.6
3/4	1/64	112	56.0	32.7
	1/32	89.2	44.6	26.0
	1/16	66.2	33.1	19.3
	3/32	55.2	27.6	16.1
	1/8	48.3	24.2	14.1
	3/16	39.7	19.8	11.6

Standard 1 inch Tool

Depth of Cut in Inches	Feed in Inches	Soft Cast Iron	Medium Cast Iron	Hard Cast Iron
3/32	1/64	226	113	66.0
	1/32	177	88.4	51.6
	1/16	130	64.8	37.8
	3/32	107	53.5	31.2
	1/8	92.8	46.4	27.1
	3/16	75.7	37.8	22.1
1/8	1/64	205	102	59.8
	1/32	160	85.1	46.8
	1/16	118	58.8	34.3
	3/32	97.0	48.5	23.3
	1/8	84.2	42.1	24.6
	3/16	68.6	34.3	20.0
3/16	1/64	181	90.6	52.9
	1/32	142	70.8	41.3
	1/16	104	51.9	30.3
	3/32	85.8	42.9	25.0
	1/8	74.3	37.2	21.7
	3/16	60.6	30.3	17.7
1/4	1/64	165	82.3	48.1
	1/32	129	64.4	37.5
	1/16	94.3	47.1	27.5
	3/32	77.8	38.9	22.7
	1/8	67.5	33.7	19.7
	3/16	55.0	27.5	16.1
3/8	1/64	143	71.5	41.8
	1/32	112	56.0	32.6
	1/16	81.9	41.0	23.9
	3/32	67.6	33.8	19.7
	1/8	58.6	29.3	17.1
	3/16	57.5	28.7	16.8
1/2	1/64	132	66.2	38.6
	1/32	104	51.6	30.2
	1/16	75.8	37.9	22.1
	3/32	62.6	31.3	18.3
	1/8	54.2	27.1	15.8
	3/16	44.2	22.1	12.9

Standard 7/8 inch Tool

Depth of Cut in Inches	Feed in Inches	Soft Cast Iron	Medium Cast Iron	Hard Cast Iron
3/32	1/64	220	110	64.2
	1/32	169	84.6	49.4
	1/16	122	61.2	35.7
	3/32	99.8	49.9	29.1
	1/8	86.4	43.2	25.2
	3/16	70.1	35.1	20.5
1/8	1/64	202	101	58.9
	1/32	156	77.8	45.4
	1/16	112	56.2	32.8
	3/32	91.8	45.9	26.8
	1/8	79.3	39.7	23.2
	3/16	64.3	32.2	18.8

Fred W. Taylor, Proceedings of A. S. M. E., December, 1906.

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LATHE CUTTING SPEEDS, CAST IRON.—II.

Cutting Speed, in feet per minute for a tool which is to last 1 hour and 30 minutes before regrinding

Standard 7/8 inch Tool (Continued)

Depth of Cut in Inches	Feed in Inches	Soft Cast Iron	Medium Cast Iron	Hard Cast Iron
3/16	1/64	178	89.0	52.0
	1/32	137	68.6	40.1
	1/16	99.4	49.7	29.0
	3/32	81.0	40.5	23.7
	1/8	70.1	35.0	20.5
	3/16	56.8	28.4	16.6
1/4	1/64	163	81.5	47.7
	1/32	126	62.9	36.7
	1/16	90.8	45.4	26.5
	3/32	74.1	37.0	21.6
	1/8	64.1	32.0	18.7
	3/16	52.0	26.0	15.2
3/8	1/64	144	71.8	41.9
	1/32	111	55.4	32.3
	1/16	80.0	40.0	23.4
	3/32	65.3	32.6	19.1
	1/8	56.4	28.2	16.5
	3/16	45.8	22.9	13.4
1/2	1/64	135	67.5	39.4
	1/32	104	52.1	30.4
	1/16	75.2	37.6	22.0
	3/32	61.4	30.7	17.9
	1/8	43.1	21.6	12.6

Standard 3/4 inch Tool

Depth of Cut in Inches	Feed in Inches	Soft Cast Iron	Medium Cast Iron	Hard Cast Iron
3/32	1/64	222	111	65.0
	1/32	169	84.3	49.2
	1/16	120	59.8	34.9
	3/32	97.0	48.5	28.3
	1/8	83.4	41.7	24.4
	3/16	66.4	33.2	19.4
1/8	1/64	203	102	59.3
	1/32	156	78.2	45.6
	1/16	110	55.0	32.0
	3/32	88.8	44.4	25.9
	1/8	76.2	38.1	22.3
	3/16	60.9	30.4	17.8
3/16	1/64	181	90.6	52.9
	1/32	137	68.5	40.0
	1/16	97.7	48.9	28.5
	3/32	78.0	39.0	22.8
	1/8	67.5	33.7	19.7
	3/16	54.2	27.1	15.8
1/4	1/64	167	83.6	48.8
	1/32	126	63.2	36.9
	1/16	90.8	45.4	26.3
	3/32	72.7	36.3	21.2
	1/8	62.7	31.3	18.3
3/8	1/64	150	75.0	43.8
	1/32	113	56.7	33.1
	1/16	81.0	40.5	23.6
	3/32	65.5	32.7	19.1

Standard 5/8 inch Tool

Depth of Cut in Inches	Feed in Inches	Soft Cast Iron	Medium Cast Iron	Hard Cast Iron
3/32	1/64	216	108	63.0
	1/32	160	80.0	46.6
	1/16	110	55.0	32.2
	3/32	88.4	44.2	25.8
	1/8	75.4	37.7	22.0
1/8	1/64	200	100	58.6
	1/32	148	74.0	43.3
	1/16	104	51.8	30.2
	3/32	82.6	41.3	24.1
	1/8	69.6	34.8	20.3
3/16	1/64	183	91.6	68.0
	1/32	135	67.5	39.4
	1/16	94.0	47.0	27.4
	3/32	75.4	37.7	22.0
	1/8	64.3	32.2	18.8
1/4	1/64	171	85.7	50.1
	1/32	126	63.2	36.9
	1/16	87.8	43.9	25.6
	3/32	70.4	35.2	20.6
3/8	1/64	156	77.8	45.4
	1/32	116	57.8	33.8
	1/16	79.7	39.9	23.3

Standard 1/2 inch Tool

Depth of Cut in Inches	Feed in Inches	Soft Cast Iron	Medium Cast Iron	Hard Cast Iron
3/32	1/64	206	103	60.0
	1/32	147	73.3	42.8
	1/16	97.5	48.8	28.5
	3/32	76.0	38.0	22.2
	1/8	64.1	32.1	18.7
1/8	1/64	194	97.0	56.7
	1/32	138	69.3	40.4
	1/16	93.1	46.5	27.2
	3/32	72.1	36.1	21.3
	1/8	41.8	20.9	12.2
3/16	1/64	182	91.0	53.0
	1/32	128	64.0	37.7
	1/16	86.1	43.1	25.1
	3/32	67.4	33.7	19.6
1/4	1/64	173	86.3	50.4
	1/32	122	61.0	35.7
	1/16	81.9	41.0	23.9

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